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THE BASIC CAUSE OF INCREASED EFFICIENCY.

By Walter M. McFarland.

Mr. McFarland believes that in industrial organization the human element is vastly the most important factor, and that increased efficiency is to be obtained principally through the stimulation of the *personnel* by a system of individual reward. In the following pages he elaborates this view in convincing fashion, drawing his illustrations from ancient military history, from modern industry, and from recent experience in the United States Navy.—THE EDITORS.

IT is probable that there was never a time when there was not an effort on the part of some especially energetic individuals to bring about an improvement in existing methods, but with the advent of the steam engine as an active factor in human affairs, this effort for improvement has become more marked, with an intensity which has been steadily growing, down to the present time, so far as relates to increased efficiency of machines. The improvement has come about partly by good fortune, partly by experiments (not always well directed), and partly as the result of effort directed by a thorough knowledge of theory. The last quarter-century has witnessed a greater concentration of effort towards the increase of efficiency in the human element, and it is proposed to discuss briefly what is really the basis for the undoubted improvement which has resulted.

It is one of the elementary chapters in political economy which proves that unorganized society is of necessity inefficient, and the books go on to show that specialization produces a decided increase in the individual and the general efficiency. This is true even on a small scale. When the scale of operations is greatly increased, we find, as we might expect, that thorough training and organization are productive of increased efficiency, as is notably shown in the history of armies in ancient times.

The great success of Alexander in his expedition through Asia is attributed in part to the fine organization and drill of the army by his father, Philip, who in turn was a pupil of Epaminondas. The latter was apparently the inventor of the first material change in tactics in introducing a movement similar to the flying wedge, which was popular in football some years ago. The utilization of this idea in his battles was a great feature in Alexander's victories. In the same way the successes of Hannibal against the Romans were apparently due to the much higher skill and training of his officers and men, under the direction of his consummate generalship. Organization and drill alone, however, are not sufficient, as was shown in a most remarkable way in Napoleon's campaigns. Leaving aside for the moment the marvellous military genius of Napoleon and the great ability of some of his chief lieutenants, the fact remains that prior to the Revolution none of them had had any experience in battles on a large scale and they were often pitted against veteran commanders of many years' experience. They had troops who were comparatively raw, and the enemy in many cases had troops who were veterans. There must be some reason for the immensely greater efficiency which was developed, and it seems, on even moderate analysis, to rest upon a basis of rewards of some kind. In the early days—those of Alexander and Hannibal—it was expected that the victorious army, besides receiving its usual pay, would glut itself with loot. We may not regard a spirit thus satisfied as of a very high grade; but for the time the incentive was thoroughly adequate. Hannibal's soldiers were all mercenaries and had no patriotic impulses to influence them in the slightest degree, while the Romans were fighting for their country. Something of the same sort was true of Alexander's men, as we know that it was customary among the Greek soldiers to hire out their services. In the case of Napoleon's armies, there can be no doubt whatever that the splendid rewards which he held out for splendid services were calculated to bring out the very best work of which each man was capable. It was commonly said that every soldier carried a marshal's baton in his knapsack, and we know that a majority of his marshals actually rose from the ranks.

The very difference in quality between the men who are usually obtained for soldiers in peace and those who enter the service during a war emphasizes this point. In times of peace there is ordinarily little chance for an enlisted man to get much advancement. In war, for a bold and brave man there are splendid opportunities; and the history of the American Civil War, with the large number of men who entered as privates and afterwards became officers of the regular

army, shows the much greater opportunity. An actual count of a recent Army Register showed sixty general officers (two lieutenant-generals) who had risen from the ranks and whose names were on the list. We can see all these things very clearly now when we look back and study them, but in times of general indifference or stagnation this basic principle seems to be entirely ignored.

In the early days of hand-workmanship, men were either their own masters or, at least, worked in small groups where they were thoroughly under the master's eye, so that questions of organization did not enter. The advent of the steam engine, and following it the growth of the factory system, changed the problem of craftsmanship almost completely and in a way to make the questions of organization and discipline somewhat analogous to those obtaining in military organizations. When the factories were still small and the masters could be personally acquainted with every man, so that there was a personal touch, there was still something of pride on the part of all decent workmen in rendering an adequate return for the wage received; but with the development into the huge establishments of recent years this personal touch has been entirely lost, and it is an undoubted fact that there has been a tendency on the part of the men to render less than an adequate return for their wage.

Two methods are always open in handling large bodies of men—by leading or by driving. With work that requires no particular skill and mere brute strength, the method of driving may succeed moderately; this was the method in both ancient and modern times of handling slaves. Where the skill of the workmen is involved, however, driving is practically out of the question. Something can be accomplished, but there is almost sure to be a reduction in quality of product. We then come to exactly what was found two-thousand years ago in the military organization—that to get zealous and efficient work, an adequate reward must be offered.

It can hardly be asserted with confidence that in industrial lines the perfect system of reward has yet been discovered—that is, one which, while perfectly just in theory to master and man, is accepted cheerfully by both. Piece work seemed very promising (and it certainly is just) but in one way it did even more than was expected. It proved almost always that the men had produced so much less than was easily possible that the masters would have been more than human if they had not cut the piece-work rate, and, of course, the result was strikes and other troubles. Then came the premium system, which seemed to be entirely fair to both masters and men; but the labor organizations are against this because they claim that it leads men

to produce too much, thereby throwing many out of employment. Others, like Mr. F. W. Taylor and his followers, have shown very admirably how a proper bonus system would produce the proper results, although this would doubtless be opposed by the labor agitators. There can be no doubt whatever that all of these systems have shown very thoroughly that they do offer an adequate reward to men who are willing to be fair, and that, as a result, the efficiency of work and of the plants is enormously increased. It will, of course, be understood that it is assumed that the other essentials of success—proper organization, modern labor-saving methods, etc., are to go along with the factor specially affecting the *personnel*—but I believe that the human factor is vastly the more important.

It is very interesting to look at the history of the United States Navy in the last forty years, as showing how the application of this same basic principle has been productive of splendid results. For a period extending from shortly after the Civil War until almost the beginning of this century, the promotion of officers was absolutely by seniority, this in turn depending on vacancies produced by natural causes alone, thus assuring extreme slowness in attaining higher rank. As if this were not enough to discourage able men, in 1882 the number of officers was reduced, making it almost certain that a lifetime would be spent in the lower grades. The natural result followed, and a great many very able young officers, whose services should never have been lost, left the Navy to engage in private business with its much greater pecuniary reward. In 1897 the Personnel Board, under the chairmanship of Mr. Roosevelt, then Assistant Secretary of the Navy, provided for a steady flow of promotion, which would guarantee to competent officers that they would get to positions of importance, with reasonable compensation, before they were old men. This system has been in operation now for about ten years only, yet the results are shown by an almost complete absence of resignations. The bright men, whom the Government has educated at great expense, are retained in the service, and it would require inducements which very few outside concerns would be prepared to offer, to get them to leave. Indeed, the prospects of any but the most brilliant men below the age of thirty are now much better in the Navy than in business life. Incidentally it may be remarked that the only thing that did keep the good men who remained in the service during these discouraging times was the assurance of a fixed tenure of office and the retired list in old age or in the case of breakdown. These, however, are rewards—although inadequate for the ablest men, the very ones whose resignation should have been made almost impossible.

In the case of the enlisted *personnel,* for a long time there was little inducement for good men to make more than one cruise. At the end of his period of enlistment a man was discharged with practically no better claim for preferential treatment when re-enlisted than one without this previous experience. The first improvement was what was known as "the continuous service system," which provided that men who had made a good record could have a vacation of three months with pay, provided they re-enlisted at its end (the pay being given on re-enlistment) and during this re-enlistment their pay was increased. The effect of this was excellent and brought a better class of men into the service.

A mistaken notion as to methods of discipline had provided that, in the vast majority of cases, petty officers were always to be appointed by the commanding officer of the ship for the time being. The law permitted the captain to punish by "reduction of any rating established by himself" without a court martial, thus enabling prompt, but often unjust, action to be taken. In fact, it made the tenure of these offices depend on the impulse, if not the whim, of the captain, as the punishment was almost invariably summary and under the stress of the moment. A court martial, at least, would have let everybody cool off. Within the last twenty years a far better system has been adopted in giving competent petty officers who have proved their ability a permanent appointment on the recommendation of the captain. These appointments can, however, be revoked by sentence of court martial, just as a commissioned officer may lose his commission. It is astonishing that people in high positions often ignore the fact that human nature is pretty much alike in all grades. Thus it was not at first generally realized that the men would prize these permanent appointments almost as highly as the commissioned officer does his commission. My personal experience while a naval officer showed, however, that the men do prize these permanent appointments very highly, and it is an undoubted fact that the change has tremendously raised the standard of efficiency among the petty officers of the Navy.

With the greatly increased interest in naval matters which has obtained in the United States since the Spanish-American war, everybody has read with pride of the great improvement in the gunnery records, until the experts tell us that the efficiency is now very high indeed, perhaps the highest in the world. Without detracting in the least from the credit due the officers who have been instrumental in bringing this about, nor from the effect due to emulation and competition among the ships of the fleet, there can hardly be any doubt

that the basic principle of adequate reward for efficiency has had a tremendous influence in the improvement. Reference to the official documents shows that a material inducement is offered for skill as gun pointers. The Naval Year Book for 1907 says:

"Enlisted men of the Navy, after having qualified as gun pointers and who are regularly detailed as gun pointers by the commanding officer of the vessel, receive monthly *in addition* to the pay of their respective ratings extra pay as follows:—

Heavy gun pointers,	
First class	$10.00
Second class	6.00
Intermediate gun pointers,	
First class	8.00
Second class	4.00
Secondary gun pointers,	
First class	4.00
Second class	2.00

Men detailed as gun captains receive $5.00 per month additional pay."

These sums may not seem large to those who do not know the rates of pay in the Navy, but the highest figure means an increase of from 20 to 40 per cent of the monthly pay. Such a percentage increase for greater efficiency would be considered very liberal indeed in industrial work.

Quite a long list could be made up of the various items of extra pay which are given to men in the Navy for qualifying for important positions. It all comes to this—that dependence is no longer placed alone on the skill of the officer, however great, in imparting instruction, or in driving the men, but actual individual reward is offered for excellence.

As illustrating in a somewhat different way how men respond and adjust themselves to reward, or, what comes to the same thing, the maximum satisfaction for a given amount of effort, two instances that came under my observation while in the Navy are very interesting. One cruise was made on a vessel whose executive officer was, in most respects, a very able man. Discipline in general was admirable. In arranging for shore leave of the enlisted men, however, he managed so to arrange matters, strange as it may seem, that it was possible for a man in an inferior conduct grade to get more liberty than one of the best-behaved men. This was, of course, entirely unnatural and came about from a combination of two separate systems. The reason was that naval regulations compelled the giving of at least a certain amount of shore leave to men in the second grade,

while the system he was using actually allowed less to a man in the first grade. The result was that in a short time the bulk of the men were in the second conduct grade where they could get the most liberty. At a later date, on another ship, the executive officer was an extremely able man, who had studied this question more carefully and was a great believer in making it worth while for the men to behave themselves and keep in a high-conduct grade. He so arranged matters that if any man behaved himself sufficiently well and did all his work with high efficiency he could have an unusual amount of liberty. The result was that this ship had more than half its crew in what is known as the "special first class," far and away the largest percentage that ever came under my observation.

When the Engineer Corps of the Navy was absorbed into the line at the suggestion of Captain (now Admiral) Evans, I believed that this was only a first step and that ultimately all of the enlisted force would likewise be trained to do double duty, both with the battery and with the machinery. It is obviously, therefore, quite appropriate that a discussion of some aspects of naval efficiency should be conducted in THE ENGINEERING MAGAZINE, because the modern Navy has become more and more an engineering organization.

I assume that it will not be supposed, because I do not discuss other vital elements to efficiency, such as proper organization, thorough discipline, specialization, etc., that I underrate them, but it has seemed to me that in many of the schemes which are put forward for increased efficiency there is too great a tendency to assume that the human beings who have to carry them out are machines. This mistake is akin to that which is so often made where it is believed that an evil can be cured by simply passing a law against it, forgetting that public opinion must be back of the law.

In these days, some branches of business, notably advertising and selling, are showing a firm belief in the truth of Pope's saying "The proper study of mankind is man," with splendid results. They aim to show a man that it is to his interest to buy. What we have to do in production is to show the men that it is to their interest to produce with the highest efficiency. The most practical way to do this—is it not indeed the only way?—is to provide an adequate reward. The rare men who are sure to rise to higher positions are naturally satisfied with this as their reward; but the vast majority cannot hope to rise higher than skilled artificers. These men have exactly the same human nature as the executives of the establishment, and what causes the executives to be efficient will certainly have the same effect upon the workmen—and this is adequate reward for the highest efficiency.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

VI. THE MODERN THEORY OF COST ACCOUNTING.

The parts of Mr. Emerson's series, which began in our issue for July last, already presented have discussed the world-wide evils of inefficiency in almost every branch of human activity; the peculiar national qualities which have thus far helped the leading industrial nations to mitigate the losses due to inefficiency; the necessity for supplementing the line system of organization on which industrial management principally depends with modern staff organization; the relation of standards to organization and to results; and, last month, the realization of standards in practice.

In the following pages Mr. Emerson outlines the theory that actual costs must be subdivided into standard costs and preventable wastes; that standard costs must be based on full equivalency in service rendered for money spent; that standard costs must always be predetermined; that average wastes are part of general expense and can be currently anticipated; that the chief duty of the operator is the maintenance of all standards; and that cost standards can only be attained through methods, records, ideals and checks furnished jointly by the comptroller and the efficiency engineer to the executive line officials.—THE EDITORS.

THERE are two radically different methods of ascertaining costs, the first method to ascertain them after the work is completed, the second method to ascertain them before the work is undertaken. The first method is the old one, still used in most manufacturing and maintenance undertakings; the second method is the new one, beginning to be used in some very large plants, where its feasibility and practical value have already been demonstrated.

The objections to the old method are not only that it delays information until little value is left in it, but that it is wholly and absolutely incorrect, mixing up with costs incidents that do not have the remotest direct connection with them, so that analysis of cost statements, as, for instance, repair costs per locomotive mile, does not lead to elimination of wastes. The advantages of the second method are not only that costs must be ascertained before the work is begun, but that the costs as finally tabulated are the real costs divided as to each unit, whether a single element or aggregated out of a million separate elements (1) into standard expense and (2) into avoidable loss. An analysis of costs so stated, facilitates an almost inexorable elimination of inefficient conditions of all kinds, standard expenses being constantly standardized at new levels—wastes, as to standards, being constantly removed.

The general method of anticipation as opposed to the method of retrospect is not a new one, and has already largely made its way in other lines of human activity. The old method was to call out the priests and tom-toms when an eclipse was occurring and thus drive away the devil who was eating the sun. The modern method is to predict the eclipses decades or centuries in advance, and check up our clocks, watches and calendars by the actual occurrence. Under the old method the farmer planted what seed he had, fertilized it with any available manure, and trusted to nature to do the rest. The modern farmer predetermines conditions, selects and tests in advance special seed, feeds the soil with chemically adjusted fertilizer, irrigates scientifically, and trusts as little as possible to nature. In California he forces the lemon trees to bear for the Fourth of July and the orange trees to bear for Christmas. In hygiene, the old method is to wait until a whole community is infested with yellow fever or bubonic plague and then to quarantine and use chloride of lime; the newer method is to prevent the mosquitoes potentially capable of carrying the germs of yellow fever from ever being born, and to kill off the rats and ground squirrels that carry the fleas whose saliva infects the human body with bubos. In travel, the old method was to start an ox team from St. Joseph for California and to arrive somewhere between six months and a year after the start. The new method is to leave San Francisco on the minute, and to arrive in New York on the Century Limited also on the minute. That precision and exactness are more largely due to organization than to conditions is proved by the fact that the pony express of fifty years ago which made its runs between Sacramento and St. Joseph, a distance of nearly 2,000 miles, under unparalleledly adverse conditions of Indian hostility and climatic accident, adhered more closely to time schedule than many a modern railroad. In ocean travel the old method was to sail at some indefinite date from Europe and to arrive at a more indefinite date in America, much as Columbus did on his first voyage, an uncertainty of a couple of months not mattering; but the modern method is to build vessels whose exact speed is predetermined before the keel is laid, as for the Lusitania and Mauretania, which leave port on the minute and arrive almost on the hour.

Predetermination of results is the main characteristic of the modern method. The acceptance of the hap-hazard is the main characteristic of the old method, still in full and orthodox standing in cost accounting. Predetermination of results is based on scientific certainties modified by experience. It ought not to be necessary to prove

that retrospect costs based on servile record of the hap-hazard cannot be of value, but actual illustrations from actual practice of their unreliability may hasten the conversion of those who are still skeptical.

Two closely similar types of locomotives were operating on a great railroad, one type in the east, the other in the west, both doing virtually the same work. The vice-president of the road desired to order a large number of new locomotives of the general type in question. He called for the records of the two classes and found that the locomotives operating in the west cost $0.14 per mile for maintenance, but that the locomotives in the east cost $0.10 per mile for maintenance. With these records before him he felt inclined to order the type costing for repairs $0.10 per mile. The facts were, however, that the western round-houses and repair shops were operating at 50 per cent efficiency and the eastern shops and round-houses at 80 per cent efficiency, so that the real respective costs of the locomotives were for the western $0.07 per mile and for the eastern $0.08 per mile. In this case so-called actual costs were expensively misleading.

A large manufacturing plant turned out forty special machines at a hap-hazard labor cost of $400,000, or $10,000 each, but after they were completed and the costs tabulated, the manager declared that if he were given another similar lot, the labor cost would not exceed $5,000 each. Was the $200,000 extra cost of the first lot real cost, or was it the cost of inefficiency due to unstandardized operations?

A waiter bringing in an expensive dinner to a guest at a hotel stumbles and crashes dinner and dishes to ruin. Shall the guest, besides being put to the annoyance of waiting another half hour, be charged not only double price for his dinner, but also for the broken dishes, or is the expense of the accident to be charged to inefficiency, a general overhead burden on all dining-room operations, taken care of in the standardized cost of each dish, without reference to specific accident?

There was a railroad shop in which charges were distributed with such painful care that the shop sweepers subdivided their time to the various locomotives around which they loitered. But locomotives, as well as men, can loiter, and one of the locomotives stood in this shop three months waiting for a steel deck plate. Being familiar with its number, the workers charged all the time they could not readily account for to this locomotive, so that at the end of three months the total amounted to more than $5,000. The fictitious accuracy as to the sweepers' time made more glaring the gross falsity of the locomotive charge. In principle there is no difference between charging

an hour of wholly wasted time to a locomotive and charging it with two hours of time when one hour should have accomplished the work. The moment specific wastes of any kind are charged to a definite order instead of being charged to some inefficiency account, real costs are vitiated.

Assuming, under the old method, an elaborately carried out cost system, anywhere from one to two months after the operation is completed there may be put up to the superintendent in tabulated form comparative records covering many thousand different operations. The superintendent does not have any time himself to examine all these different records, so he entrusts the work to a clerk, often without shop experience, instructing him to bring up those records that require investigation. The clerk who has learned to apply "the method of exceptions" passes over as satisfactory those costs that show slight change from previous records and notes down for action those that show great variations. Because costs are not standardized, the variations due to inefficiency under identical conditions are in the records either increased or lessened by the much larger variations due to change of conditions. It is evident that a job done one month under 100 per cent conditions, but with 60 per cent labor efficiency, may equal in cost the same job done another month under 60-per cent conditions but 100 per cent labor efficiency. The tabulated costs of this job show no variation and are consequently passed as satisfactory, although in both cases as to half of the elements the expense is 25 per cent too high. In another case, perhaps, the clerk notes that one month the surfacing of a slide valve is reported to have cost $37.00 and in another month to have cost $3.65. Having found, as it seems to him, a variation worth following up, he begins an interminable and irritating investigation. The foreman in whose department the discrepancy occurred denies it, claiming that the accounting department is in error. If the time and cost accounting is so accurately looked after that it can be demonstrated that the first order was done by an expensive man on a big slow machine, with a very high hour rate, but that the cheaper second order was done by a low-priced man, on a small quick machine, with a low hourly rate, then as to this six-weeks-old occurrence the foreman advances plausible excuses—the little suitable machine was otherwise employed—the expensive man was out of work—it was in any case an emergency job and the customer had to pay for it—so the investigation results in naught in the way of cost reduction, but the whole system is discredited both in the opinion of the foreman and of the superintendent,

and the cost clerk soon ceases to take more than perfunctory interest in his duties.

The human mind is curiously irrational and perverse. The Chinese are more interested in their ancestors than in their children, and other individuals besides the Chinese are more interested in tracing their descent to the 1024th part, even on the wrong side of the blanket, of some rascally nobleman, than in training their own children in paths of righteousness. If the object of cost accounting is to record fictitious and valueless genealogies, then the old methods should be given Godspeed; but if the object of cost accounting is to record accurately present facts and facilitate future improvements, then the new method alone is suitable. The old system of cost accounting is deficient firstly because it looks backwards instead of forwards, and it is even more deficient because it has failed to recognize the difference between exchange and equivalency. A birthright may be sold for a mess of pottage. This is exchange without equivalence. When 100,000 bushels of wheat of certified grade are exchanged at the market quotation, for dollars, there is both exchange and equivalence, the operation being reversible, as the money can be immediately reconverted into wheat with only a small frictional loss. In this operation of exchange with equivalence the Government not only standardizes the dollar, but it puts its stamp on the standard dollar—the grade of the wheat is certified to by qualified and approved inspectors—the scales on which wheat is weighed are inspected as to accuracy.

It is, however, only recently that Governments have furnished the standard dollars now used in exchange. When I was studying commercial law at a German commercial school, most of my time, that might have been better employed, was wasted in learning to value and reduce to a common denominator the various coins of brass, tin, copper, silver, gold and platinum which were currently used to settle balances. Before Napoleon made a cleaning up in Germany there were some three-hundred independent States, each with its own rights of coinage and money issue. Many of these issues were still current in 1870, and without an assay and metal market quotations as to value there was nothing definite in a safe full of alleged money. The *Thaler* or *Gulden* was indeed standardized at so many grains of silver, but the current coins were not *Thalers* or *Guldens* and had first to be reduced to *Thaler* or *Gulden* values. Similarly today in operating concerns there are many expressions, as "a day's work," "a pound of material," "the performance of a machine;" but exactly what constitutes a fair day's work, how far a pound of material should go, and

what a machine should do per hour, have only in a few cases been determined. They should be predetermined in all cases.

The modern method of cost accounting anticipates standard expenses because it first determines equivalency between dollars spent and standard service. In the mining of precious metals, as also in the German banker's assay of the strange coins he handled, there has always been this determination of equivalency. An ounce of pure gold is worth $20.67; an ounce of alloyed and impure gold is worth $20.67 multiplied by an efficiency figure which may be anything from 99.99 per cent down to a fraction of one per cent. Whatever the mixture, whatever the ore or coins, sample and assay determine the value per ounce, thus determining the efficiency coefficient. As in mining and in former coin assays, so also in modern cost accounting there must be initial determination of equivalency, standard equivalency consisting for dollars paid out, of actual costs multiplied by current coefficient of efficiency. In present commercial transactions the old time slugs and base coins of every kind, country, and date have been eliminated. Dollars, francs, sovereigns and marks, all definitely and precisely related to one another, constitute the common standards of the commercial world, but in industrial equivalency we are still in the dark ages.

It is the function of the efficiency engineer to give the industrial and operating world:

1.—Standards as definite as the dollar, franc, sovereign or mark, for all services, materials, or equipment operations.

2.—To make assays, as definite and reliable as the assayer's determination of bullion values, of all current operations, thus establishing current efficiency.

3.—To provide remedies which will bring current efficiency (often, one might say usually, only 50 per cent of what it should be) up to 100 per cent.

It is the function of the comptroller, auditor, accountant, to locate and record all expenditures, to locate and record all receipts.

Both comptroller or auditor and efficiency engineer are staff officers the work of each of whom is supplementary to that of the other and who both together supply the line officers with the tools and the methods needed to carry on operations with exact knowledge as to cost and efficiency.

Because efficiency is the most important item in modern costs, the modern comptroller and the efficiency engineer must affiliate, associate, so that they may jointly solve the problem, the efficiency engineer

being deprived of his most powerful instrument of determination and betterment if the comptroller does not supply him with the necessary current and correct records which he needs. The effect of association of comptroller and efficiency engineer on costs will be illustrated for a specific case, any other possible case being capable of similar solution, the illustration being used, not to show the results of efficiency, but to show how the auditor and the efficiency engineer, before any current work is begun, can predetermine standard costs and current efficiency, ultimately making the latter 100 per cent.

It is evident, when the efficiency engineer predetermines standard costs, that the difference between standard costs and actual costs is the volume of the loss due to inefficiency. It is also evident that if by assays the efficiency engineer ascertains current wastes, he is able to determine standard costs by deducting the wastes from actual costs.

When standard costs are adopted the efficiency engineer is pledged to supply methods which will eliminate the wasteful difference between standard and actual costs, and from time to time, as this work of elimination progresses, standard costs will themselves be revised, sometimes upwards, sometimes downwards, since the basic elements of costs, materials, services and operations are not constant in value.

Predetermination of cost on the basis of standard cost and inefficiency charges will be illustrated by a cost item of railroad operation. A certain railroad operated 1,000 locomotives. Test questions put by bankers, investors, officials are: What is the cost of locomotive repairs per mile? What should be the cost of locomotive repairs per mile? The auditor answers the first question, the efficiency engineer answers the second question; and only where they have worked in harmony are the two answers the same. The staff officer in charge of the accounts, whatever his title—comptroller, general auditor or vice-president—carries his organization as to methods of accounting and checking down to the minutest details. The efficiency engineer's work runs parallel with the auditor's from top to bottom, but on a wholly different line, much as telegraph lines run parallel to railroad lines, each having relations to the same operation, train movement, at every station. In accounting the auditor is responsible for correct cost statements as to every item of expense, and the efficiency engineer is responsible for correct cost attainments—namely, 100 per cent efficiency, as to every service, material issue, or equipment operation.

As a preliminary to co-operation, the efficiency engineer learns that the mileage of locomotives is approximately known, because engineers and firemen are paid on the mileage basis, and that the total annual

mileage for the 1,000 locomotives is 30,000,000 miles; that under the Interstate Commerce provisions, all costs of labor and material for locomotive repairs have been charged to one given account whose total for the previous fiscal year was $3,000,000. This works out to a mile cost for repairs of $0.10. The efficiency engineer then goes over the road, makes numerous assay tests of service, of material used, of equipment operation, and while there is great variation in individual assays, some running as low as 5 per cent and others as high as 100 per cent, it is his opinion that the road assays as to this account, 60 per cent of standard; that costs are therefore 67 per cent higher than they ought to be. The accountant thereupon divides his estimate for the coming year into two parts and adopts (on the recommendation of the efficiency engineer) $0.06 as standard of average repair cost per mile, and he adopts 60 per cent as the current efficiency factor, carrying the remaining charge of $0.04 to a preventable waste account. Until further notice any average expense for repairs above $0.06 is considered preventable loss.

It is the business of the efficiency engineer to eliminate wastes, and it is the business of the auditor to carry the accounts in such a manner as to record the results of the efforts of the efficiency engineer. The initial 60 per cent efficiency should gradually increase to 100 per cent and the auditor is to record the increase. The president of the company is advised by the auditor that repair costs as standardized by the efficiency engineer are $0.06 per mile, and that preventable losses amount to $0.04 per mile. The proportionate loss due to inefficiency is 40 per cent, and if current yearly mileage is to be 36,000,000 miles (on basis of current wastes) the loss will be $1,440,000, which loss, if his original assay is correct, it is the task of the efficiency engineer attaining 100 per cent to eliminate, just as certainly as the Century Limited can make the Chicago-New York run in 18 hours.

The president need not look deeper than the standard of $0.06 per average mile, and the efficiency for the total account of 60 per cent. The standard will not be changed for a year—although ultimately it might be made $0.055 or even $0.05, standards being wholly distinct from efficiency—but from month to month the president will watch the efficiency factor and expect to see it rise from the initial 60 per cent to a final 100 per cent, actual costs per mile correspondingly dropping from $0.10 to $0.06. It is, however, not the cost per mile but the *efficiency* which is important. A severe winter might occur, greatly adding to repair costs; a round-house might burn down

and damage many locomotives. If all the necessary repairs are made at 100 per cent efficiency, officers and shareholders will have to be content, even though the standard cost has to be advanced after all consideration and for sufficient reason to $0.10 a mile. On the other hand, extraordinarily favorable conditions may drive the actual costs down to $0.05, but if average efficiency in details is only 50 per cent, officers and shareholders know that $0.05 is not low but twice what it ought to be. In the effort for economy many railroads have been making records of low cost which are wholly fictitious, since necessary work has not been done, standards are not maintained and inefficiency as shown by the labor and operation assay is even greater than usual.

To attain 100 per cent efficiency—$0.06 a mile—and to record the downward progress from $0.10, are respective duties of the two staff officers, efficiency engineer and auditor. The latter meets the former's needs in the way of records and accounts. As the largest operating units are the divisions of the road, and as locomotive operation is about 30 per cent of the total road-operating expense, the efficiency engineer asks the auditor to subdivide operations, all the expenses for services, for materials, and for equipment operation (as to locomotive repair accounts),

1.—To separate locomotives;

2.—To the respective divisions;

3.—To the kind of work done, as tire turning, flue welding, etc.

From these records it will be possible to tell not only what each separate locomotive costs per year, but also what each class of work costs. On many roads charges are already subdivided to respective divisions, on others, even to separate locomotives, although not in such a way as to be of any practical use, but it has not been usual to classify as to operations because this has hitherto served no purpose from an exclusively accounting point of view.

Necessary records being available, the efficiency engineer investigates divisions, shops, round-houses, locomotives, and operations. He finds that shop conditions on one division are only 50 per cent, on another 70 per cent, and he forthwith adopts such remedies as will most rapidly bring up the inefficient divisions. He may find, for instance, that lighting and heating or other elementary sanitary conditions on a division are so poor that the men, even with best intentions, lose 25 per cent of their time. Some of this can be remedied, often in a surprisingly easy manner, or work can be diverted to the more efficient shops. The policy of concentration of work at efficient points is steadily pursued. In a given instance, a boiler-shop punch

made by day work at an outlying shop cost for labor $6.00, the same punch made on an automatic machine at a central shop costing for labor $0.06.

When it is stated that an efficiency engineer brings about improvements it is to be remembered that he is a staff officer—that he merely provides standards for the officials to follow—that he may indeed establish a standard of 60 per cent efficiency below which no man ought to be permanently retained in the service of the company, but being a staff officer he will not directly discharge an employee, although the efficiency standing is only 10 per cent. Discharge is the prerogative of the line officer. As a staff officer, the accountant may report that a given locomotive costs $0.20 a mile to maintain, while another locomotive on the same kind of work costs only $0.08; as a staff officer the efficiency engineer may report that $0.20 a mile is 100 per cent performance while the $0.08 is only 80 per cent performance; but neither the auditor nor the efficiency engineer has the right to order the uneconomical locomotive out of service.

High cost and inefficiency are not identical. High cost may occur with high efficiency, low cost may occur with low efficiency. The Indian who carried 250 pounds on his back over Chilkoot Pass in Alaska at the time of the Yukon gold rush was tremendously efficient but the method was costly, rates being $0.60 a pound. This is an illustration of high cost and high efficiency. The Alaskan locomotive which today hauls freight over the neighboring White Pass may be very inefficient, only able to drag half a normal load, yet the rate is down to $0.02 a pound. This is relatively low cost combined with low efficiency. The railroads of the United States carry freight at lower rates than any other railroads—cost of service is relatively low. Many of the operating and maintenance methods are extremely wasteful, at least 50 per cent above reasonable standard, therefore efficiency is very low, but the low costs of service are not the result of inefficiency.

Just as the shops are each separately investigated in the pursuance of the work, so the conditions as to locomotive operation are investigated as to each division. Surprising troubles are often revealed. One railroad on which efficiency work was undertaken had neither turn-tables nor round-houses large enough to turn certain new locomotives; on another road some of the curves were so sharp that decapod locomotives could not back over them. In another case the tracks leading to the main round-house were so easily blocked that it was almost impossible to move locomotives in or out. An engineer experienced in detecting inefficiencies will discover a vast number of

conditions that are not standard, but which can be easily improved by the line officers, and which when improved will bring up the efficiency factor of the division. No divisional factor can increase without bettering the system factor. If for instance the system factor is 60 per cent, the division one-tenth of the system, when the divisional factor is advanced from 65 per cent to 75 per cent, the system factor will advance to 61 per cent.

Records being available for each separate locomotive, each is investigated both as to performance and as to cost of maintenance. The efficiency engineer establishes new measures, new methods of comparison unknown either to operating officials or to accountants. He knows that repair costs per locomotive mile are, from an efficiency point of view, meaningless. One locomotive weighs 400,000 pounds, another only 40,000; one locomotive operates on 3 per-cent grades, another on level track. He therefore uses such measures as the tractive-weight mile, which compensates for weight and also, fairly well, for the difference between freight and passenger locomotives. He establishes a standard allowance of $1.00 of repairs per ton of coal burned, and on the basis of grade and service he establishes a standard of fuel allowance.

The measuring appliances and methods of the standard-practice engineer, innumerable in their variety, are invented and applied so as to test and gauge efficiency. As to all his own measures he seeks the co-operation of the accountant, without whose figures it is impossible to record definitely and reliably the progress made, or the reverse. As a general proposition those tabulated records, which involve, directly or indirectly, equivalency in money, will be maintained by the auditor; those records which involve other equivalents, foreign to the auditor's experience (as pressures or temperatures, or chemical analysis) will not be looked after by him.

The measures and methods of the efficiency engineer can be divided into two main classes, those that affect general conditions, and those that secure special results. General conditions are those that affect the good and the bad alike, as good equipment, good operating conditions and administration. Special results are secured only through high individual performance, whether the individual is a person, a machine, a material issue or an operation however complicated. The next essay will outline the specific methods and records evolved and used jointly by auditing and efficiency engineers to locate and eliminate wastes.

THE ECONOMY OF THE INDIVIDUAL MOTOR DRIVE FOR MACHINE TOOLS.

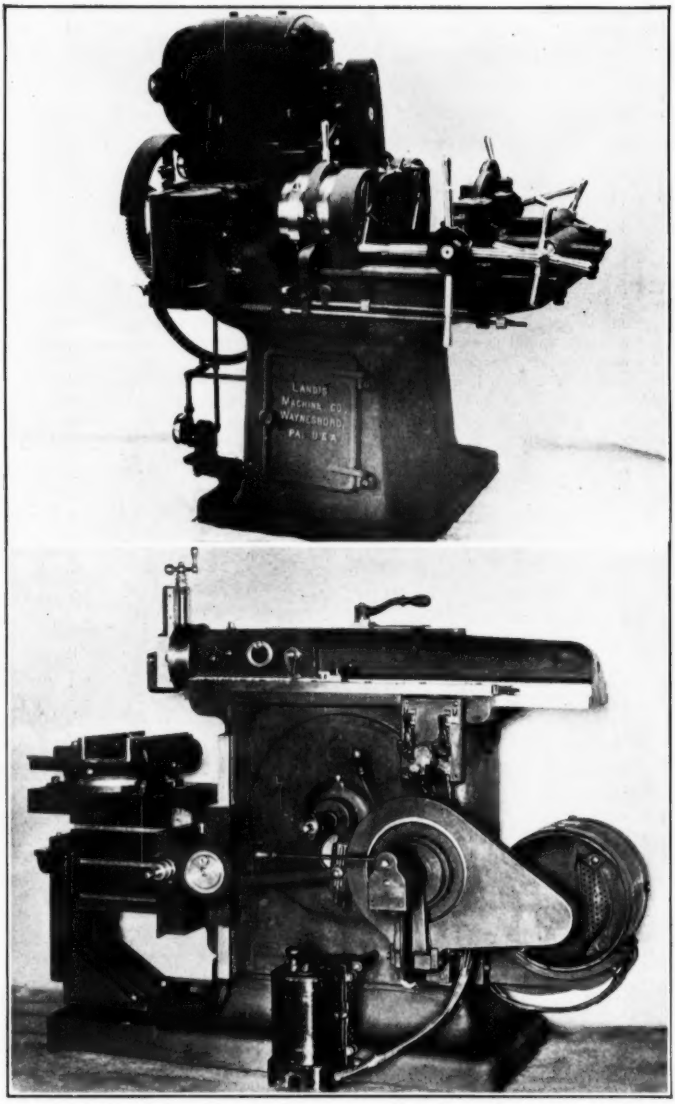
By Howard S. Knowlton.

Mr. Knowlton covers the argument for individual electric driving effectively, concisely, and as fully as possible without going too far into the intricate task of tabulating figures of cost-reduction in special cases. He points out, however, that electric driving permits the actual cost of machine operations to be determined and recorded, and enables remediable inefficiencies to be corrected, with a certainty and accuracy never before possible. As the machine-hour element of cost, in many cases of production, is one of the largest factors, an improvement like electric driving which increases the capacity of the machine has enormous potentiality for cost reduction.—THE EDITORS.

NO one who follows closely the application of the electric motor to every variety of industry can doubt that the most striking tendency of this development is the advance of the individual method of machine-tool driving, in preference to the group plan. It has naturally been to the manufacturer's interest to encourage the use of separate motors as far as possible, but the results obtained in comparison with the best methods of group driving prove conclusively that when a company can afford the additional cost of separate motors, their use, in the great majority of cases, is the best solution of the problem.

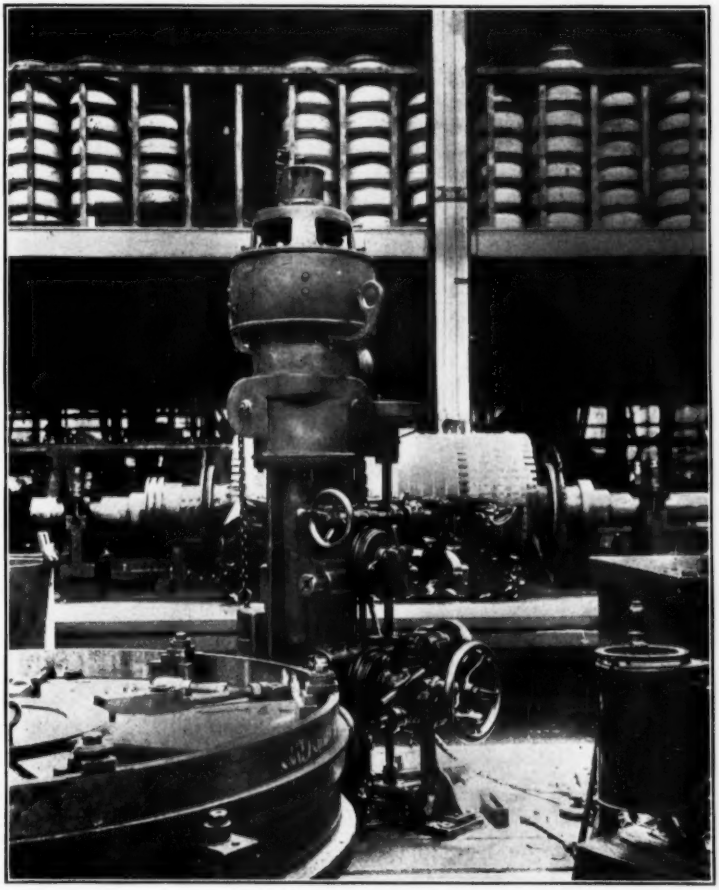
The group method of driving still has its field of usefulness, notably in industries where there are large numbers of small machines to be driven together at a constant speed on the same kind of work. Thus, in the shoe industry, in the modern textile plant, and in many other lines of trade where the stock handled is light, where the machinery in a given department consists of a large number of units operating in production multiple, as it were, and where overhead-crane and hoisting facilities are not needed, the group system is likely to find favor for some time to come. Sooner or later the advantages of the separate drive are certain to be felt, even in fields where at present the group drive has pre-eminence.

Unless each machine in a plant where speed control and tool capacity are important factors in the production is separately driven, the full advantages of the electric drive cannot be enjoyed. With a single motor per tool, the latter can at all times be run at its max-



GENERAL ELECTRIC MOTORS OPERATING INDIVIDUAL MACHINE TOOLS.

In the Landis bolt cutter, the 5 horse-power motor is mounted so as to save floor space; the Stockbridge 24-inch shaper is driven by silent chain, with automatic tightener, the motor being of 500 to 1,500 revolutions, placed out of the way of chips.

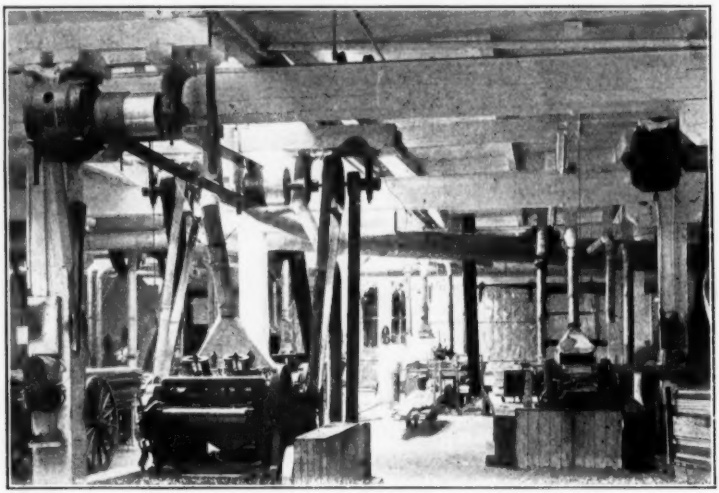


DRILLING MACHINE DRIVEN BY WESTINGHOUSE VERTICAL ENCLOSED MOTOR.

An example of direct application where compactness is vital to convenient service. The motor is enclosed to prevent injury by the work handled by the drill or by the cranes; it is controlled near the floor level.

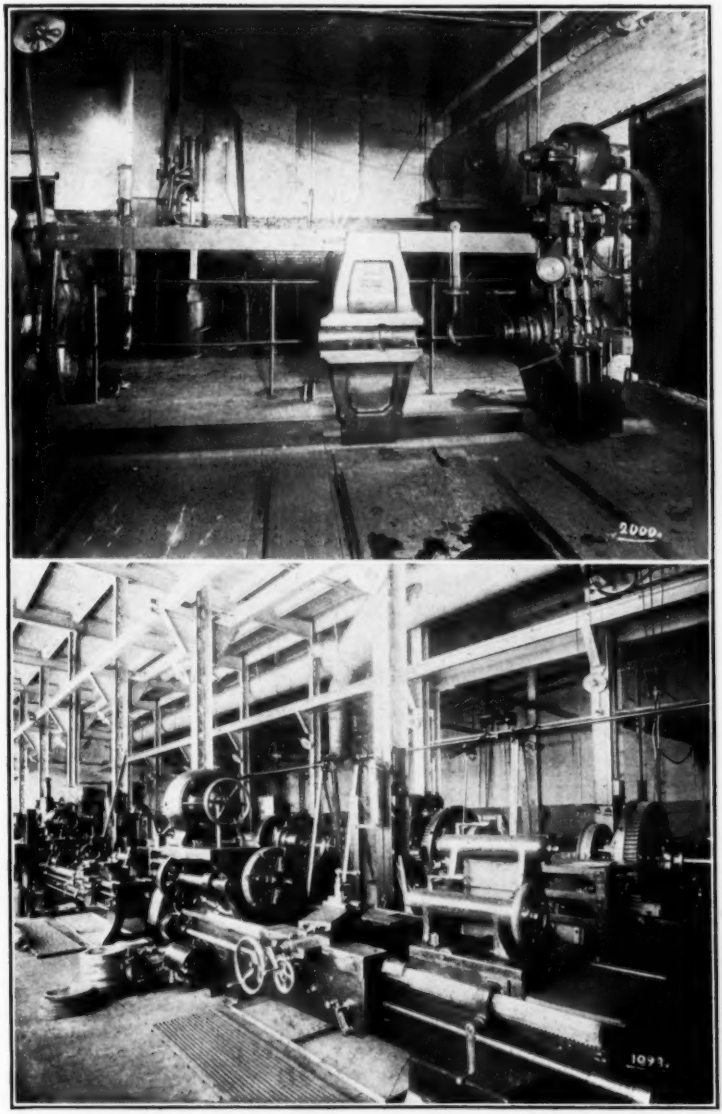
imum cutting speed; and with direct connection, there is no trouble about securing the necessary pulling power. The latter point is of great importance in applying motors to old tools formerly belt-driven. An old tool can often have its speed of operation increased two or three fold by direct motor application, for the reason that the strains on the machine are those due to the torque required to make a given cut. With this given cut, the speed may be increased three and often

four fold without producing any greater strains on the machine itself, because of the constancy of the torque. Of course, the power required increases in proportion to the speed, and this is the factor that limits the ordinary belted tool, whether driven by an engine and line shafting or by short runs of shaft and belts propelled by motors on the group-installation scheme. The belt simply will not transmit the necessary power without slipping.



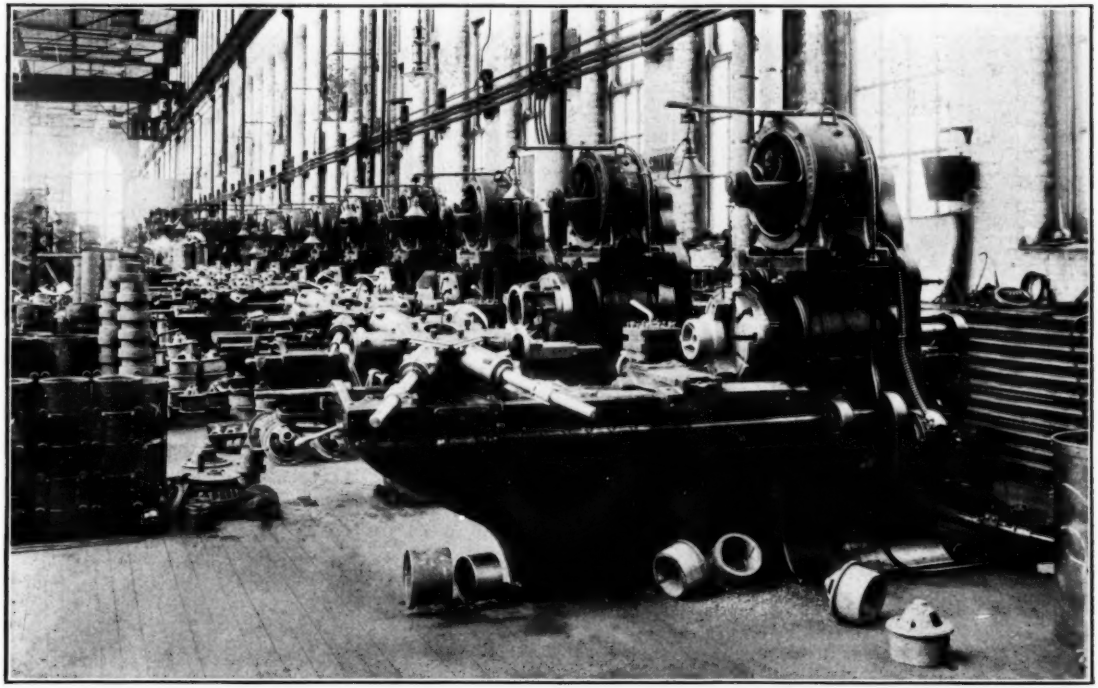
LUMBER MILL MACHINERY OPERATED BY ALLIS-CHALMERS INDUCTION MOTORS. Fifteen motors are used in this section of the mill. The sticker and surfacer in the foreground are each driven by a 20 horse-power motor.

It is interesting to consider the advantages of electric driving from the standpoint of the direct-connected against the group-driven installation, and to note how much more the economies and improved conditions due to electricity are available in the plant using individual motors. In a mechanically driven plant of the old style, the belt and shafting equipment, when all the tools are in operation, may easily absorb from 25 to 60 per cent of the power developed by the engine. If only a few of the machines happen to be in service, the useful power required may be but 20 per cent or even less of the total generated power. In other words, four-fifths of the coal burned in such a plant for power purposes is thrown away in the friction of the driving apparatus, to say nothing of the time lost from production on account of stopping to take up belts. The reduction of the shafting by the installation of a group-driven system will greatly better this condition, but until all overhead belts are cut out and until there are no



NORTHERN ELECTRIC MANUFACTURING COMPANY MOTORS OPERATING INDIVIDUAL MACHINES.

The upper view shows a Watson-Stillman 150-ton wheel press; the lower one, a J. J. McCabe double-spindle lathe, 26 by 48 inches. Both are in the shops of the Transit Development Company, Brooklyn, N. Y.



BATTERY OF TURRET LATHES IN THE FACTORY OF THE WESTERN ELECTRIC COMPANY, HAWTHORN, ILL.

Each is driven by a separate Western Electric motor; maximum of light is secured, unimpeded by belts, rendering conditions perfect in point of visibility for production of work up to maximum capacity of lathe.

short lengths of countershafting to absorb energy, as in the group drive even under the most favorable circumstances, the conditions will not be at their best. The maintenance of even the simple line shafting and belts, pulleys, and countershafts required in a group-driven installation takes far more attention than is generally appreciated, and when it comes to the operation of overhead traveling hoists for more quickly serving individual tools, even the well designed group installation has its serious drawbacks on the score of danger and delay; in fact, it is often the case that a group-driven layout of tools cannot be provided with better hoisting facilities than obtained in the original engine-operated installation.

It was well said in a recent publication of the General Electric Company on the "Application of Small Motors to Machine Tools," that when the separate tools in a shop are each driven by an individual motor, the power used is so nearly proportional to the work done that the individual motors are all "piece workers," and "there are no gangs of shafts, pulleys and belts putting in their time while running idle."

With the individual drive the speed control of the separate machines is far better than under the majority of group systems, and the tools can be better arranged. Just as the group drive is far more flexible than the old belt and shafting method, so is the application of a separate motor to each tool, in an increasing number of cases, better practice than any attempt (on the score of a saving of perhaps 25 or 30 per cent in first cost) to drive the equipment by a few large motors, which must almost always be placed overhead and take up room which would be available for other purposes under the direct-connected drive. It is not always the case that the original installation of motor-driven tools is the best after a service trial has been made, but if the system installed is on the group plan, it may be a difficult problem to make the necessary changes. Not as hard, of course, as with the old engine drive, but still troublesome enough sometimes to preclude the most efficient arrangement of the machinery with reference to the production process.

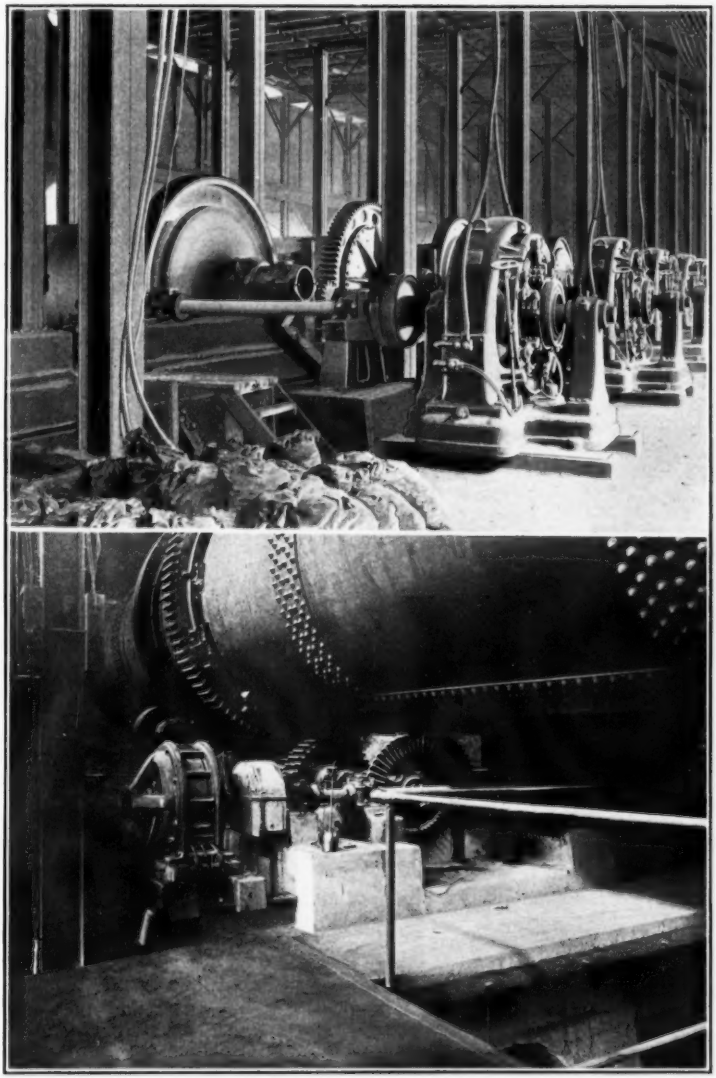
Another feature of the direct drive which commends itself in times of heavy output in manufacturing plants is the ease with which several motors direct-connected to tools can be set up temporarily in a distant part of a shop to handle some rush job that cannot be taken care of in the regular departments, particularly at times when a great deal of special work is under way. If the plant facing such a condition has to install a system of short belts and shafting on the group principle, not only is the time required greater, but the adjustment of the tools to the job and securing of the most economical speeds will

prove a much more troublesome matter. In point of cleanliness, the direct drive is far ahead of the group system, as well as in safety to employees and improved appearance of the shop.

In regard to the equipment of old tools with electric driving, it is no doubt somewhat cheaper to use the group method, but the application of the individual drive to the old tool is now a comparatively easy problem, on its technical side, except where a very great range in speed is required. The recent development of the commutating pole motor enables most cases of forcing the production rate of old tools by separate motor application and the use of high-speed steel to be handled with success. It is sometimes thought that the use of individual motors on old tools is not worth while, but the increases in capacity that have resulted in innumerable cases prove the contrary.

The salient features of a number of recent applications of this character may be briefly touched upon to show the ease with which the matter has been handled. The design of small motors with a casting to carry a back gear enables such machines to be applied to a great number of tools by simply mounting them upon a bracket where they can mesh with the gearing of the old tool. These brackets can be had in all sorts of shapes and sizes and are easily attached and removed in case the motor is needed at some other point. The enclosure of both gear and pinion in such cases reduces to a minimum the chance of accident, and the mechanical stability of the motor and the tool are all that can be desired. Both direct and alternating-current motors can be provided, in small sizes as well as in the larger units, with special frames and back gearing with the same facility. No owner of a shop need hesitate to apply individual motors to his tools for fear that the arrangement of motor and tool will be mechanically unstable or in any sense a makeshift.

The individual drive can be applied in almost every necessary case so as to take up little or no more floor space measured by the rectangle included by the outlying corners of the driven machine tool. Often it is not at all necessary so to economize on space, and the motor can be allowed to overhang the tool slightly. In driving sensitive drills, for example, the motor can either be set upon the floor, mounted on the machine frame, or located on a bracket, according to the style of drill and the local space conditions in the shop. Sometimes a single motor can be geared to a pair of drills with the controller in the centre, and the resulting operation is simple provided no speed changes of any importance are required, outside the regular changes furnished by the cones. Where the direct drive is used the cost of the overhead structure is materially lessened if the plant is new, and



ABOVE, TUBE MILLS IN CEMENT WORKS DRIVEN BY WESTERN ELECTRIC MOTOR.
BELOW, ROTARY KILN DRIVEN DIRECT BY GENERAL ELECTRIC MOTOR.

Mechanical driving in such cases is cumbersome and of low efficiency; group driving would be unduly costly in operation; both would increase the cost of building construction in a class of work where low fixed charges are especially desirable.

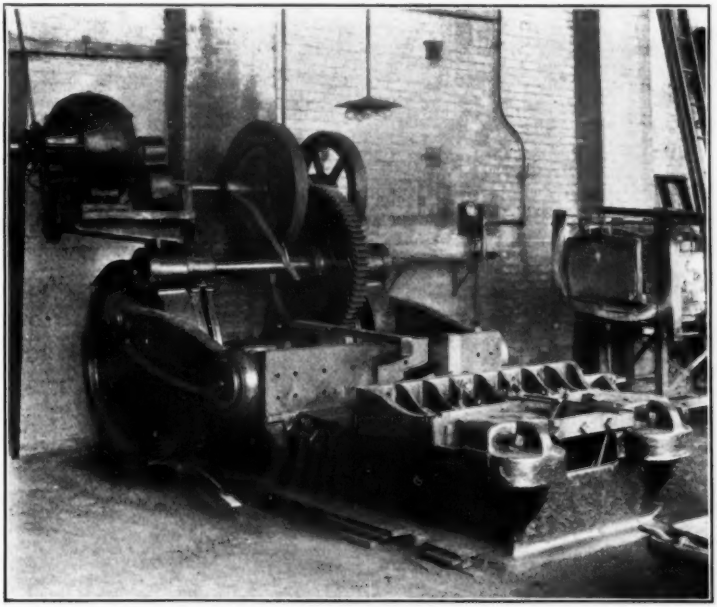
in an old plant changed over from belt to direct drive there is released additional structural strength, in a great many cases, which can be utilized in the readjustment or relocation of tools on certain ceilings and floors. In the group system these advantages are not so prominent, but the clear gain in building strength is a decided improvement in conditions in many direct-driven installations.

In some types of cutting saws the individual motor can be located on the braces of the saw frame, and thus be entirely out of the way. A cold saw driven by a small motor mounted on top of the machine tool itself is almost equally compact. Each make of tool needs special study by someone accustomed to the use of motors in all sorts of situations, for the best results. This is a field where the advice of the engineers of the district offices of the manufacturing companies is well worth securing, before trying to attach individual motors to old tools upon one's own responsibility.

An important advantage of the direct drive is the ease with which the controller may be applied to the machine tool, in cases where the speed must be varied in the cutting of a single job. In many cases of the attachment of motors to lathes, the controller is arranged to be operated from the apron, a special handle being provided for the purpose. The work is thus directly under the operator's hand. When few speed changes are required, it is even a simpler problem to locate the controller at some point near the working portion of the tool, and if on trial this point is not the best, the flexibility of the electric drive and supply of current enable a change to be made with very little trouble. Practically the same mechanical efficiency may be obtained in applying a motor to an old tool as is enjoyed in a new tool originally designed for motor driving on the direct-connected plan.

In the cases of very large and powerful tools there is a growing tendency to install more than one motor per tool in order to give the most flexible control. Thus, in the case of a large engine lathe, one motor may be installed upon the floor at the head end to mesh with the traverse gearing, and a second motor may be mounted on the lathe frame at the head of the carriage travel and meshed with the main driving gears. In the case of the turret lathe, the speed and feed conditions have been greatly improved through the use of two motors, one to operate the tool feed, and the other to run the spindle forward or backward. With automatic controllers the service that can be given by such a tool leaves little or nothing to be desired in speed range and feed adjustment. The separation of power and feed on planers has also been worked out with the most satisfying results. The close control of each factor enables every given job that the tool

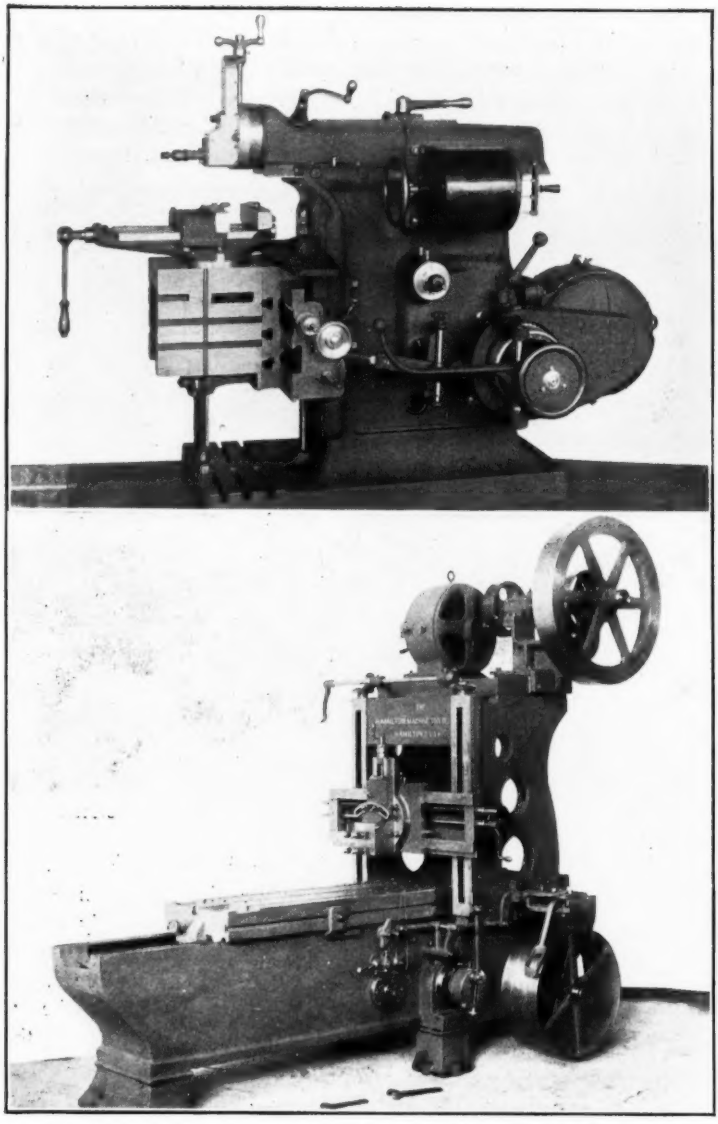
has to carry through to be done with the least delay, once it is set up, and there is little doubt that the individual drive is far superior to the group method when the setting up of heavy work is considered, for the absence of suitable hoists in some group-driven plants has slowed down the production rate of the whole establishment. The actual machining time is only one phase of the production process.



WILLIAMS & WHITE 45-INCH BULLDOZER DRIVEN BY NORTHERN ELECTRICAL MFG. COMPANY'S MOTOR.

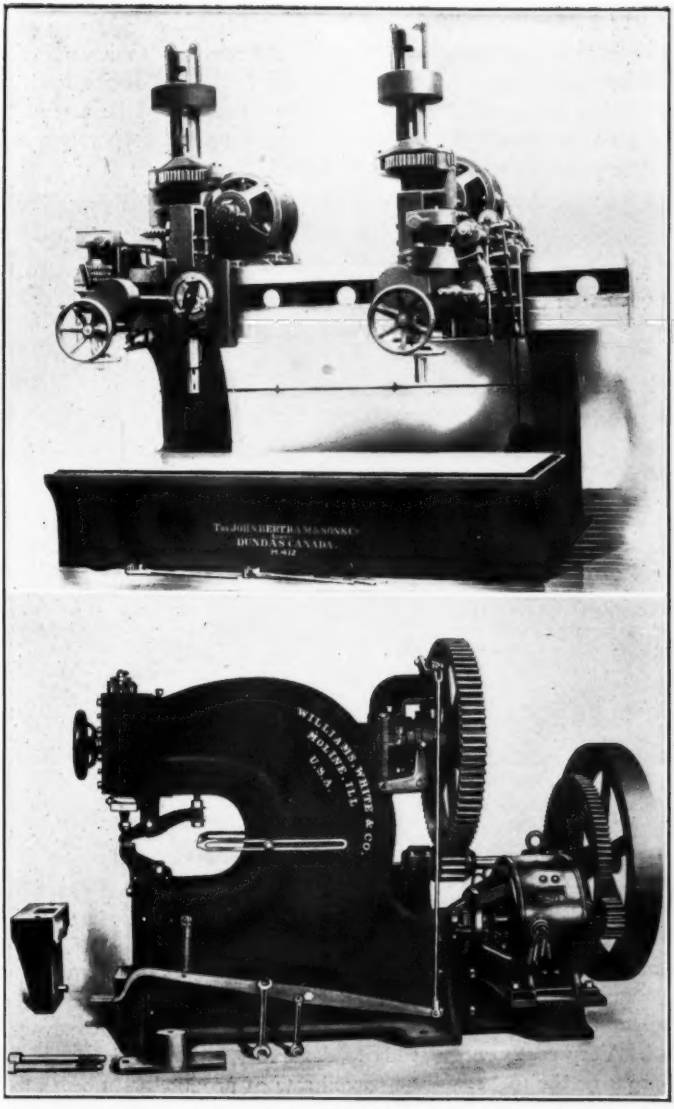
Installed at Transit Development Co. shops, Brooklyn, N. Y.

Continuous production is afforded by the direct drive in a way which few belt-driven installations can enjoy. Particularly in the driving of very large machine tools, it is being found advantageous to install separate motors to drive separate parts, such as feeds, the raising and lowering of cross rails, or the traversing of tool heads, each motor being independent of the driving motor. In this way the maximum possible output per tool can be secured, and if desired, a check upon the productivity of the workman can be made by the installation of meter recording instruments which will show the complete performance of the machine in any given period. Thus, a recording ammeter placed in the circuit supplying a machine tool, out



MACHINE TOOL INDIVIDUALLY OPERATED BY CROCKER-WHEELER MOTORS.

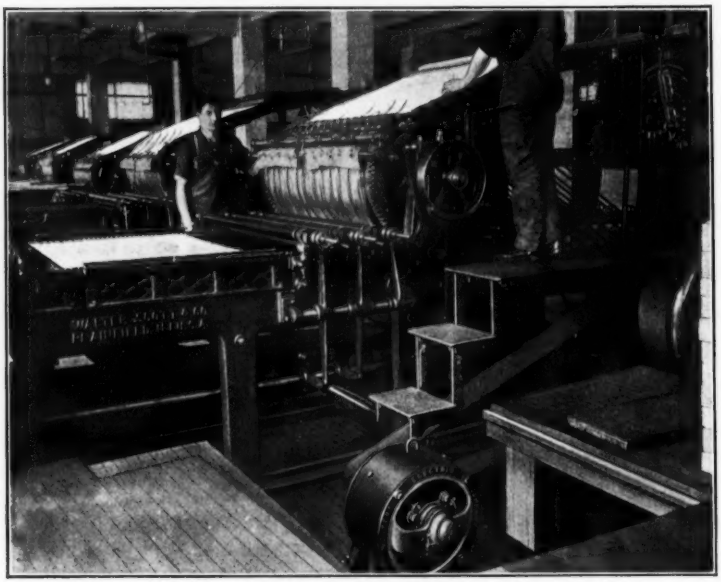
Above, a Gould & Eberhardt 16-inch shaper with 3 horse-power motor; below, 24 by 24 by 72 inch Hamilton spur-geared planer with 5 horse-power motor.



WESTINGHOUSE MOTORS APPLIED TO DRIVING OF STANDARD TYPES OF MACHINE TOOLS.

The Bertram two-spindle drilling machine is driven by a variable-speed motor; belt driving here would seriously impair the flexibility of operation. The Williams, White & Co. punch and shear is driven by 5 horse-power compound motor; this allows reduced speed when cutting and takes advantage of power-storage in the fly wheel to reduce the current demand. Lever control.

of sight of the workman, would enable the company to determine just how any particular job was handled, the regularity of the feed, rate of cutting or reversal, and other points that might be essential in any given instance. No such distant check upon the operation could well be provided with a mere mechanical drive.



SCOTT PRINTING PRESS DRIVEN BY WESTERN ELECTRIC MOTOR.
Prominent features are adjustable capacity, cleanliness, excellence of lighting conditions, and clear head room.

Since the individual drive increases the productive capacity of the tool it tends to cause a material reduction in many cases in the interest and depreciation charges against any unit of product which the machine turns out. In the case of a product where each piece is worth many thousands of dollars, it is easily possible for the time element as expressed by the machine-hour cost to offset or to be of even greater importance than the labor cost of handling the work in the tool. Very costly work tends to demand costly tools, and the fixed charges on the tool require a forced rate of production in order to insure a suitable profit. Pushing the matter still further afield, it is possible that a company equipped with individual drive, through its improved rate of production may be able to make a better delivery on a rush order than a company handicapped by the old-fashioned methods of belt and shaft driving. The only field for the group drive, is, on

the whole, that where a comparatively small number of machines, each requiring a comparatively small amount of power, are kept in continuous operation on the same class of work.

In a paper and discussion before the National Association of Box Manufacturers at a recent convention, Messrs. F. M. Kimball and L. R. Pomeroy of the General Electric Company emphasized a number of points which have a direct bearing upon the general problem of electric driving, so that a brief reference to some of these may be consistent with the present survey. One point especially emphasized by Mr. Kimball was the ease with which a check can be kept upon the condition of the tools or machines when driven by direct-connected motors. Wood-working tools, in particular, when out of alignment or carrying dull cutters, may easily absorb 200 per cent more power than they normally require, and this excess power is not only wasted, but is absorbed in friction and strains which are damaging to the machine. Under such conditions the niceties of adjustment are disarranged and the performance of the machine is liable to permanent injury. By placing an indicating wattmeter in circuit with the motor and observing its reading when the driven tool is known to be in perfect adjustment and alignment, with the cutters in good order, and comparing that reading with subsequent readings from time to time, an abnormal use of power is at once made known, and corrective measures may be applied in time to prevent serious injury.

Mr. Pomeroy presented the following results from eight cases of electric driving:

The difficulty of having at hand figures showing the direct advantage of the motor drive in dollars and cents, as applying to wood-working shops, is explained by the fact that so far, everyone adopting the electric operation of tools has taken opportunity at the same time to enlarge and improve the plants so that no direct comparison which previous conditions can be made . . . . the following facts and figures may have a relative bearing.

1. Operation-boring a cylinder.

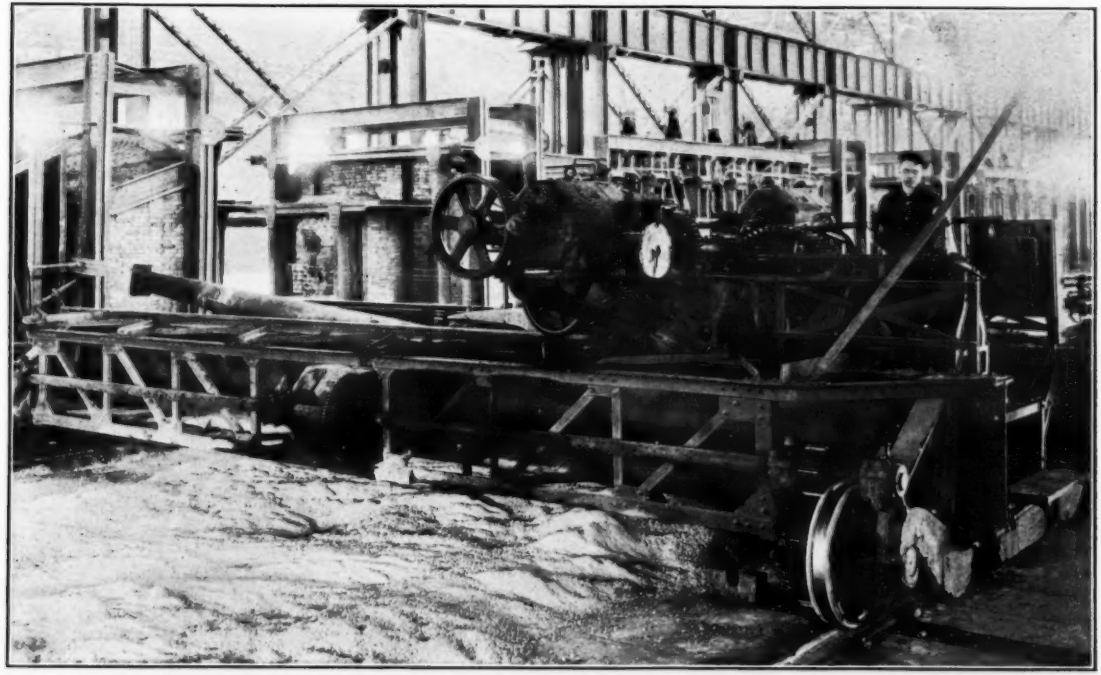
Total time, 730 minutes
Less helper's time 215 minutes.

Net time 515 minutes.

Actual time cutting, 225 minutes, or 43.5 per cent—over 50 per cent non-productive time. If only 10 per cent of this time could be saved, it would result, for a $4 per-day man, in $1,200 per annum,

INDIVIDUALLY OPERATED BOTTLING MACHINES DRIVEN BY WESTERN ELECTRIC MOTORS.

The capacity is increased 100 per cent by individual driving, on account of the facility with which the speed of production can be adjusted to the need of the work in hand.



FURNACE CHARGING MACHINE BY THE MORGAN ENGINEERING COMPANY, OPERATED BY CROCKER-WHEELER MOTORS.
Four 25 horse-power motors; installed in the works of the Pennsylvania Steel Co., Steelton, Pa.

capitalized at 10 per cent. The logic of these figures is that we could well afford to spend $1,000 if only 10 per cent saving per day could be effected. A motor would save more than this in increased efficiency alone. The particular tool in this case would require a motor costing about $120. Add to this the proportion chargeable to the motor for power plant, i. e., $140, and we have $260, or the equivalent of saving capitalized at 45 per cent.

2. A certain shop located at Richmond, Va., installed an aggregate of 1,510 horse power in motors. The average load is 30 per cent, or 450 horse power. An engine-and-belt system could easily use up this amount in friction alone. The friction load is constant and is as much when one horse power of work is being done as when the plant is carrying full load. Per contra, with motor drive, the friction load is that of one motor—if only one is in operation—and the others in proportion. The friction load in machine shops runs from 40 to 80 per cent of the original power developed by the engine.

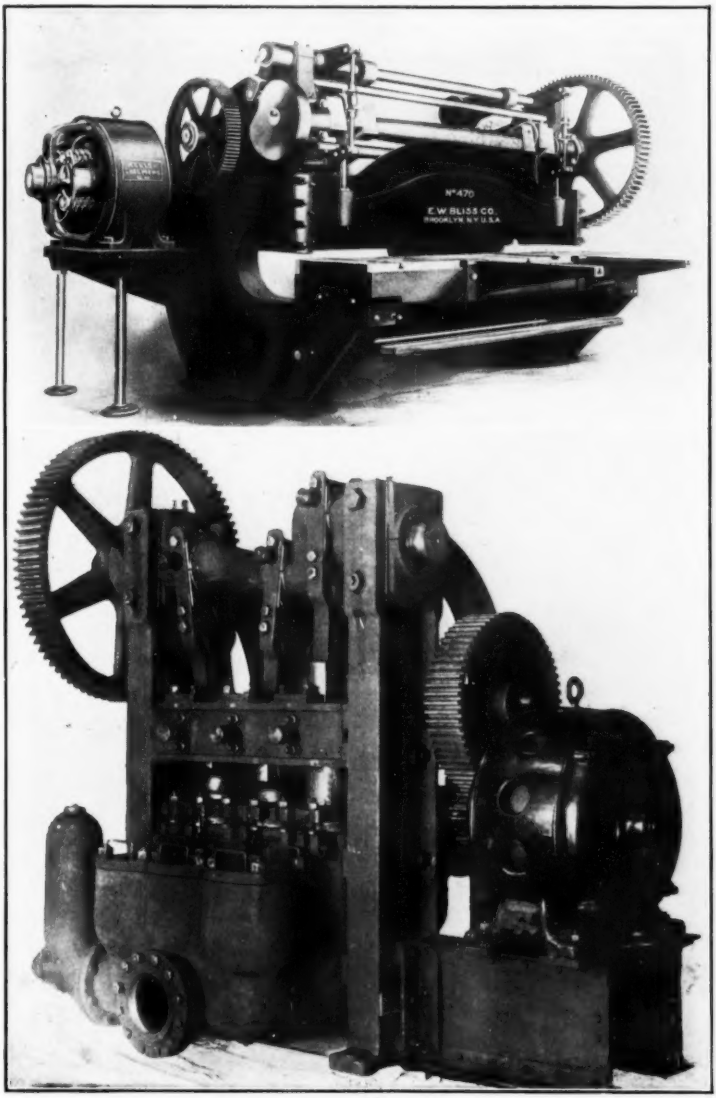
3. The annual cost for belting, for maintenance and repairs, amounts to 37 per cent of the initial cost each year. Mr. F. W. Taylor says that the average annual cost equals $6.90 per double belt per annum; say on an ordinary 40-foot double belt 8-inches wide, costing $30, the average charge amounts to $11 or 37 per cent of $30.

4. Mr. Harding, speaking of the Carnegie works at Duquesne, says that the intermittent operation of motors is carried from a central station by means of one-sixth the horse power required when individual engines were used.

5. Another large plant formerly driven by 30 separate engines, because of widely scattered buildings, saved 40,000 pounds of coal in 24 hours by adopting an electric drive from a central plant. A test from one department of this plant under the old conditions showed that the line shafts and loose pulleys consumed 61.75 horse power, or 30 per cent; machines and countershafts, 141 horse power or 61 per cent; machines cutting at normal rate, 210 horse power.

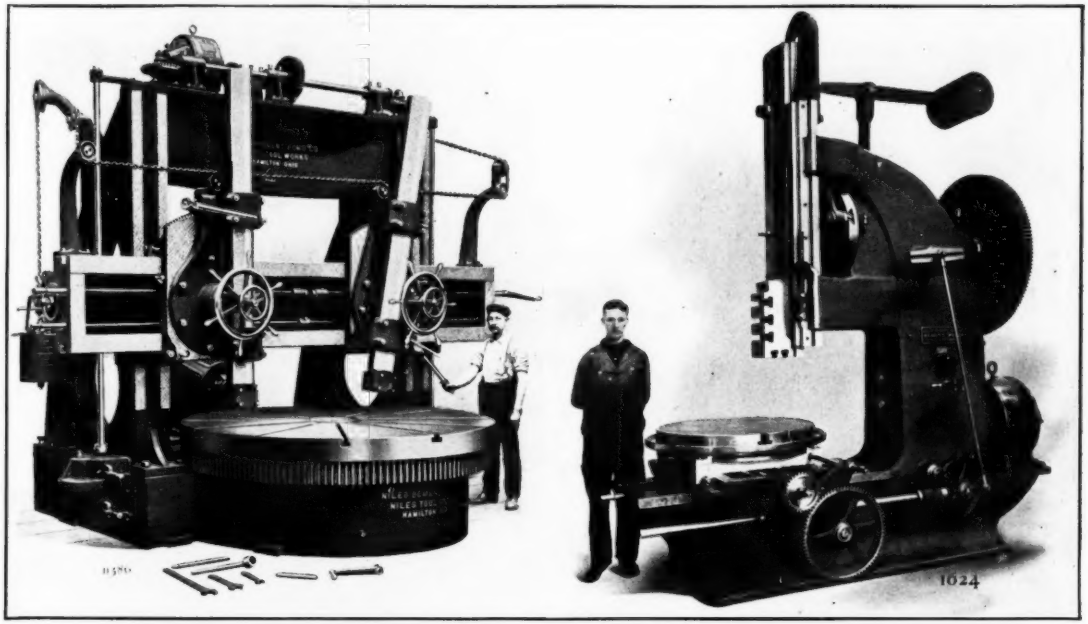
6. Mr. Vauclain, in discussing the electric drive in the Baldwin Locomotive Works, made the following statement.

> The application of electricity in the frame shop resulted in a reduction of the force of 60 per cent; while in the wheel shop the discarding of the shafting enabled the placing of one-third more wheel lathes on the same floor space. The electric traveling crane superseding the hand jib cranes reduced the common labor from 40 to 6 men, with 50 per-cent saving in power. Electricity was first introduced to drive two 100-ton cranes, resulting in an immediate saving of 80 men of the laboring force, a saving of 20 per cent in pay roll, and 40 per cent in shop area for a given product.



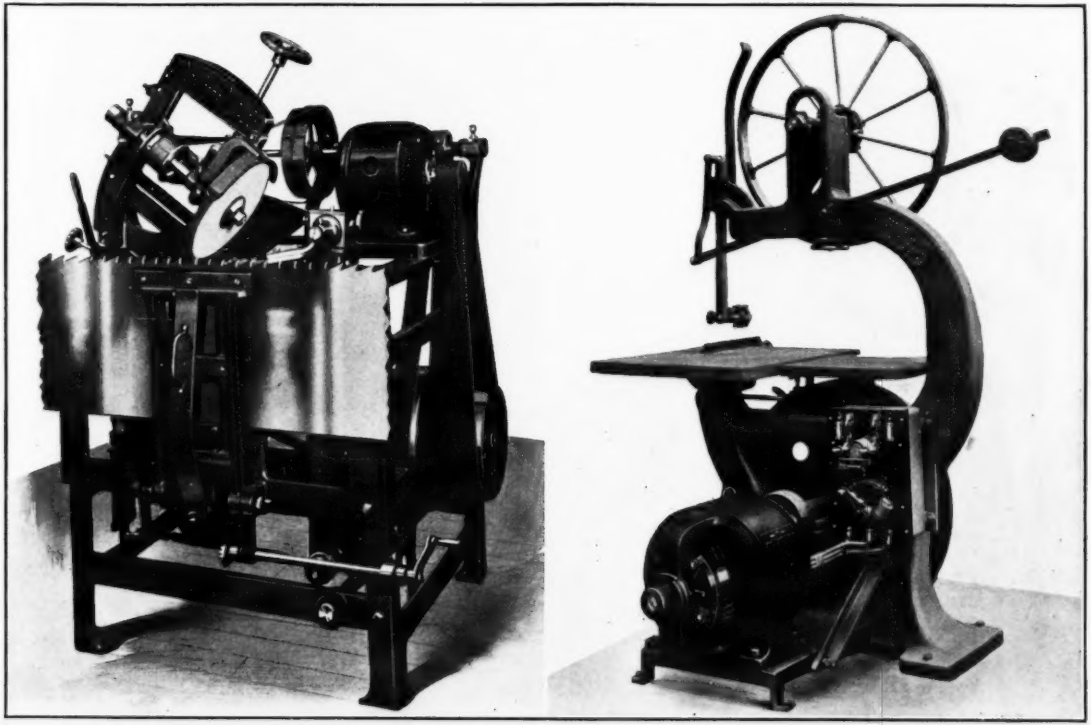
TOOLS AND MACHINERY INDIVIDUALLY OPERATED BY ALLIS-CHALMERS MOTORS.

Above, E. W. Bliss trimming and squaring shear; the motor is entirely out of the way of the stock, leaving free overhead space; below, Allentown Rolling Mills pump driven by induction motor. Adaptability of the mode of driving is illustrated by the method of supporting the motor on I beams, permitting adjustment.



LARGE MACHINE TOOLS INDIVIDUALLY DRIVEN BY WESTINGHOUSE MOTORS.

On the left is a Niles-Bement-Pond 100-inch boring mill; the two direct-current motors are out of the way of all operations but accessible for inspection and repairs. On the right is a 22-inch slotting machine by the same makers, with a 10 horse-power motor carried on a simple bracket but slightly extending the frame, and away from all probable interference with work, operations or adjustments.



MACHINES INDIVIDUALLY DRIVEN BY ALLIS-CHALMERS MOTORS.

On the left, an automatic band-saw sharpener by the Matteson Mfg. Co., driven by an induction motor; on the right, a 36-inch band saw by Greaves, Klusman & Co. The absence of belts is particularly advantageous to free handling of work.

Crane installation cost about $65,000. Sixty-five to seventy-five men would equal this amount in each year.

7. Belt drive as applied to most machines does not permit of running the tool to its limit, on an average job, while direct motor-drive does.

8. The C. M. and St. P. R. R. installed a motor on a turntable costing $550, which resulted in a wage saving of $1,600 per year.

The statement having been made that the expense for fuel in a box factory was nil, owing to the waste and shavings being utilized, figures were presented for the cost of power, entirely eliminating the fuel question on the basis of a 100 horse-power plant:

	Per horse power per year.
Labor, two men, engineer and fireman	$21.00
Water at 10 cts. per 1,000 gal	4.00
Repairs	5.00
Removing ashes	5.00
Interest and depreciation	6.00
Total per horse-power year	$41.00

Two cents per kilowatt hour at same rate (ten hour day) amounts to $45.00 per horse-power year.

There is one aspect of the individual-motor application which is still too much neglected by power users and by companies selling electrical energy. This is the keeping of accurate data in sufficient detail to furnish information of real value when problems in shop electrification come up. A recent inquiry among many central stations for engineering data in regard to individual applications of electric motors met with hearty co-operation, but unfortunately in many cases, the details of the drive were entirely unavailable without going in person to the installation where the motors were in service. It is not too much to urge that all central stations which conduct aggressive business campaigns for power take more care to secure full and complete data as to the motor applications on their circuits. The capacity and trade number and style of the driven machine are two important points to know, but in addition the size and number of teeth in gears and pinions, the size and distance between centres of pulleys, and the arrangements in force for speed control, with the range available, are all essential facts to be known in intelligently dealing with any commercial problem in the direct applications of electric motors.

RECENT DEVELOPMENTS IN MOTOR VEHICLES FOR INDUSTRIAL PURPOSES.

By Harry Wilkin Perry.

In a preceding paper Mr. Perry reviewed the most significant of the recent improvements in mechanical construction and in application of the motor vehicle to ordinary commercial transportation of merchandise. He now takes up adaptations to heavier duty, to *quasi* public service, and to peculiar and specialized purposes and uses.—THE EDITORS.

ENGLISH constructors have stuck consistently to the solution of the steam problem, and consequently are leaders in a class of vehicle that is confined almost entirely to the British Isles. This is the heavy steam wagon or "lorry," built for carrying loads of 3 to 6 tons and often supplemented by a trailer having a capacity of 2 to 4 tons. Among the many constructors of such steam wagons in England and Scotland are some of the leading engineering works of the Islands, including John I. Thornycroft & Co., the famous builders of torpedo-boat destroyers. Comparative low first cost and economy of operation are advantages of the steam wagon that offset its low speed. The prices of two such vehicles which were awarded gold medals for general excellence and performance in the British Commercial Vehicle Trials, in which they traversed 688 miles each, with loads of 11,200 pounds, approximate quite closely the sale prices of gas-engine trucks that carried loads of only 2,240 to 4,480 pounds for distances of 1,348 and 1,144 miles respectively. Gas-engine trucks capable of carrying loads of 5 tons cost fully double the selling price of the steam wagons. There is a difference in speed, however, of about 100 per cent in favor of the former, which can maintain a rate of 10 or 12 miles an hour as against the steam wagon's 5 or 6. By the use of coal or coke the cost of operation of the steam vehicle is brought down to the minimum, the consumption of coal by the Savage Brothers' entry in the British trials averaging 12.16 pounds per mile and the consumption of coke by the Yorkshire Steam Wagon Company's entry averaging 18.25 pounds per mile. The weight of these two wagons was approximately equal to the load each carried, a proportion that would hold true of most such vehicles.

There are, of course, many differences in construction between the various makes, but a brief description of the characteristics of one

YORKSHIRE FOUR-TON ENGLISH STEAM WAGON WITH TRAILER.
Photographed at completion of 40,000th mile of service.

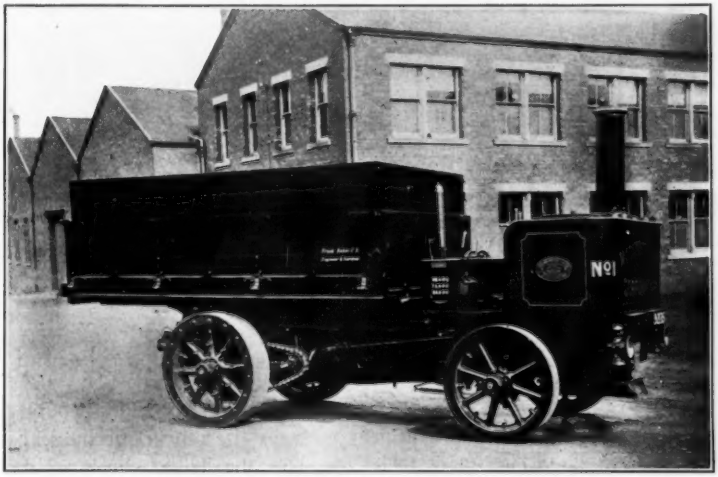
make will give a fair idea of this class of vehicle. The Leyland steam wagon has a vertical fire-tube boiler set at the extreme forward end and surrounded by the coal bunkers. The boiler has a working pressure of 200 pounds. The engine lies under the framing between the axles and is of the compound reversing double-acting type. All moving parts of the engine, together with a change-speed and reducing gear, are contained in an oil-tight casing to be partially filled with oil. There is a single speed reduction between the crank-shaft and the second motion shaft and the differential counter-shaft. The differential mechanism is so designed that it can be locked when one wheel rests in mud, sand, or on ice where its tractive effort would be wasted while the opposite wheel stood still. The boiler is fed from a water tank suspended from the main frame at the rear by a pump driven at constant speed, irrespective of the speed of the vehicle, by an eccentric on the first motion shaft. The engine cylinders are lubricated by a positive-feed lubricator. The rear wheels are fitted with weldless steel tires 10 inches broad. As this vehicle is built for municipal purposes the standard style has a tipping body, as illustrated, to be elevated at the front end by a screw mechanism that is operated with a crank from the side of the vehicle or can be arranged to work from the engine crankshaft.

Horizontal boilers are perhaps more generally employed in steam wagons than the vertical type, and are set either longitudinally or transversely, according to the preference of the designer. The engine and driving mechanism are universally placed underneath the frame where they are encased for protection. A cab usually is fitted to shelter the driver against the weather's severities.

That the item of depreciation is not excessive in the case of the steam wagon is indicated by the statement that the Yorkshire four-ton wagon and trailer, shown loaded with barrels and cases of bottled goods, has run considerably more than 40,000 miles and is still giving good service. The photograph was taken recently at the conclusion of the 40,000th mile.

Motor Road Trains.

In Europe Colonel Renard's road train has been demonstrated successfully in the military trials and manœuvres of France, Germany and other Continental countries. A more recent development in America is the Sampson road train designed and built experimentally by Alden Sampson 2nd, in Pittsfield, Mass., and exhibited for the first time at the Madison Square Garden automobile show last November. The Sampson train differs radically from the Renard train in utilizing the flexibility of electric transmission of power from the



LEYLAND STEAM TIPPING WAGON FOR MUNICIPAL WORK.

Cubic capacity of body, 6½ yd.; compound double-acting engine placed horizontally under body; vertical fire-tube boiler; overall length, 17 ft. 6 in., width, 6 ft. 9 in., height over chimney, 9 ft.; rear wheels, 42 in. diam., with 10-in. steel tires.

ABOVE, SAMPSON (AMERICAN) 20-TON ROAD TRAIN WITH ELECTRIC POWER TRANSMISSION; BELOW, RENARD (FRENCH) ROAD TRAIN WITH GASOLINE TRACTOR AND SIX-WHEEL TRAILERS.

The power plant of the Sampson train consists of a four-cylinder vertical gasoline engine driving an electric generator; each car independently driven by a pair of motors geared to center pair of wheels; steering interconnected.

power plant in the leading vehicle to each of several trailers coupled to it, whereas the French engineer conveys the power mechanically through jointed shafts and bevel gears to the drive wheels of the trailers. Both designers have adopted six-wheel support for their vehicles, driving to the center pair of each truck. The power plant of the American train consists of a four-cylinder vertical gas engine

coupled by silent chain to an electric generator, both, with their attachments, mounted under a removable hood on the front of the "tractor." Cables lead the current through a suitable controller and switches to a pair of motors on the tractor and on each trailer. Sockets at each end of each vehicle enable connection to be made or broken at will. Each motor drives one center wheel by means of a short roller chain, and since motors and wheels are independent, no differential gearing is required.

Of prime importance in road trains of this character is the means whereby the wheels of each trailer are made to follow in the tracks of the one ahead instead of describing arcs of larger radius when turning corners. This is accomplished in the Sampson train by steering with all front and rear wheels, the two pairs being connected diagonally underneath each vehicle so that they turn in opposite directions to the same angle. The steering-knuckle connecting rod of the front wheels of each trailer is pivoted to a tongue which is bolted movably to the center of the axle and whose free end is coupled to the rear of the preceding car. Whenever the angle of this tongue changes with relation to the axle, it causes a corresponding change in the position of the steering-knuckle arms, and since the rear wheels turn in a direction opposite to the front wheels they follow the same tracks. The tongues do not sustain any pulling effort, since each car is independently driven by its own motors and a constant distance between the cars is maintained by draw-bars. The capacity of this train, consisting of tractor and two trailers, is 20 tons, of which the tractor carries 4 tons. It has speeds ranging from 6 miles an hour, with full load, on hard macadam, to 1½ miles an hour up a 10 per-cent grade on soft dirt road. By the use of long cables, the tractor can supply power for moving one of the trailers in any direction at a considerable distance from itself and in places where the entire train could not go. Connection between the cars can be made equally well at either end of each, thus facilitating the making up of the train. The entire train can be steered and controlled by one man, an important factor in reducing the cost of hauling large quantities of ore, coal, rock, grain, or manufactured products over considerable distances.

Motor Vehicles in Quasi-Public Service.

Electric trucks lend themselves readily to equipment for special lines of work, where a winch of great power is required, as in hoisting safes through the windows of the upper floors of high buildings and hauling electric cables through street conduits. In several of the

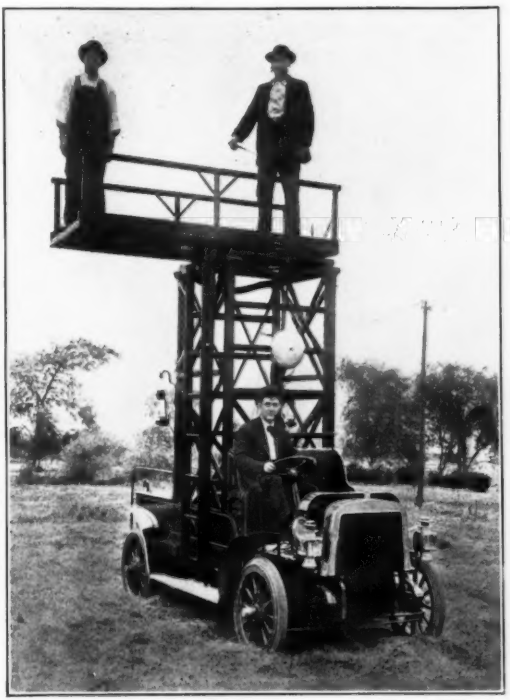
larger cities, as New York and Boston, heavy electric trucks are in constant use in this latter work by the telephone and electric-light companies. They haul the drums of cable to the scene of operations and then draw it through the conduit, doing quickly and quietly and without interference with traffic the work that formerly required a heavy capstan and six or eight laborers. The geared winch is so powerful that care must be exercised to prevent the parting of the cable.

ELECTRIC 5-TON TRUCK WITH POWER WINCH FOR HAULING CABLE THROUGH CONDUITS.

Street-railway companies employ both electric and gasoline tower wagons for erecting and repairing their overhead feed wires, and thereby effect a great saving in time, which is of utmost importance when a tie-up occurs, particularly in the rush hours. The United Railways Company of St. Louis, for example, is using a gasoline tower wagon which was built in its own shops last year. This has the advantage over the tower trolley car that it can be used when the power is off and that it does not stop the operation of cars until the repair is completed. It is easier to handle than horses on crowded streets and can be used for work on transmission lines that extend across country.

The greatest use of motor vehicles by public service corporations is in the carrying of passengers. In London alone more than one thousand motor omnibuses are now regularly in service, operated by fourteen companies and individuals, of whom eight operate from

twelve to nearly four hundred each. These run on many regular routes that thread the heart of the capital and extend out into the suburbs, several lines being as long as 20 miles. The 'buses are run on a regular schedule like street cars, at intervals of only a few minutes, and carry several million passengers annually—so many that the effect is felt keenly by the "tram" roads and underground railways, which last year reported a serious decrease of passengers. Many of the earlier omnibuses that were put in service from three to five years ago were so badly or indifferently designed and built that they were refused licenses by the police because of noisiness, inefficient brakes, top-heaviness, or inadequate prevention of dripping oil. But great improvement is shown in the later additions to the equipment of the companies. Practically all of the vehicles are fitted with double-deck bodies similar in character to the European horse-drawn 'buses. They seat sixteen passengers inside and eighteen on the upper deck. Approximately 95 per cent of the machines are driven by internal-combustion engines utilizing gasoline or kerosene for fuel, and about 75 per cent are of the Straker and Milnes-Daimler makes, almost equally divided. The Metropolitan Steam Omnibus Company, however, operates a score or more of Darracq-Serpollet



GASOLINE TOWER WAGON BUILT AND USED BY UNITED RAILWAYS COMPANY OF ST. LOUIS.
Weight with load about 4,500 lb.; speed, 20 miles an hour; double-cylinder opposed Buick engine, 25 horse power; height of tower when elevated, 19 ft.

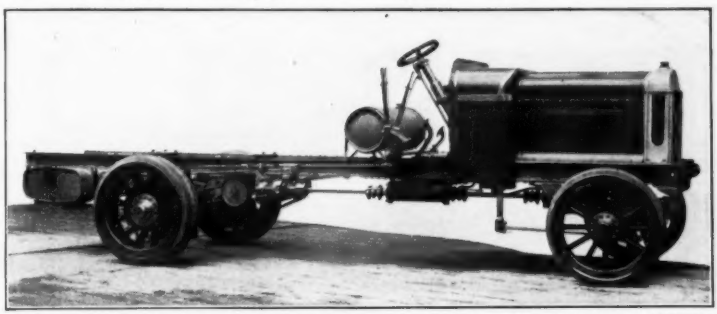
DAIMLER PETROL-ELECTRIC OMNIBUS.

MILNES-DAIMLER OMNIBUS IN SERVICE IN LONDON.

Seating capacity 16 inside, 18 on top; vertical four-cylinder 28 horse-power combustion motor; speed about 18 miles an hour.

omnibuses driven by 30 to 40 horse-power engines using super-heated steam generated in a flash boiler.

An interesting recent development in the steam-car class is the Critchley-Norris chassis which can be fitted with omnibus or merchandise body. In general appearance it is much like a gasoline car, as indeed are nearly all steam cars with the exception of the locomotive type of heavy steam wagons for loads of 4 to 6 tons. The engine is carried at the forward end under the hood and is of the single-acting type. It has three cylinders and is rated at 30 to 40 horse power. It stands vertically and has inlet valves on one side and exhaust valves on the opposite side of the cylinder heads, like many internal-combustion engines. The three cylinders are cast in one block. The steam generator is in a compartment between the engine space and the dash. A condenser occupies the usual position of the radiator.



CRITCHLEY-NORRIS ENGLISH THREE-TON STEAM CHASSIS FOR TRUCK OR OMNIBUS BODY.

Three-cylinder single-acting steam engine, vertical, with inlet and exhaust poppet valves on opposite sides of cylinder heads; cylinders 4½ by 5 in.; steam generator in compartment between engine hood and dash.

Several attempts have been made in America and elsewhere to build gasoline-electric vehicles for passenger service and for heavy freighting. In most cases the weight has been found excessive and the complication too great for dependability. One of the latest examples is the gasoline-electric omnibus built under the name Gearless by the Daimler Motor Co. Ltd., of Coventry, England. It embodies several radical departures from the usual practice. Under the hood in front is a gasoline engine of sufficient power to drive the vehicle with load under ordinary conditions. This is connected with an electric generator which is wired to a motor that drives the differential countershaft. Drive from the countershaft to the rear wheels is by encased spur gearing. Rear axle, countershaft, and motor are rigid

with relation to one another and the rear portion of the main frame rests directly upon the axle without the interposition of springs. But the front end of the frame, to which the engine and dynamo are bolted, is supported on springs mounted on the front axle. The side members of the frame are designed to permit a certain amount of twisting. The omnibus body is set upon a supplementary frame that rests on long side springs on the sub-frame and is pivoted at the front and anchored to the lower frame at the center of the rear cross member.

In ordinary running with load the vehicle uses approximately all the power developed by the engine and dynamo, but when running light the excess electrical energy generated is automatically directed into a storage battery of the Planté type. This battery is wired to the controller so that when the generator becomes unequal to the task of driving the 'bus up a grade or through heavy going with seats filled, the reserve energy accumulated by the battery is released and assists in carrying the load. Of course, the electric current is also used for lighting purposes.

Kerosene is used to a considerable extent in English motor omnibuses as well as in some heavy vans and freighting wagons as a matter of economy. In Paris, where a high duty is charged on petroleum oils entering the city, a similar economy is effected by using denatured alcohol for fuel. A service of Brillié 'buses which was started in July, 1906, and had grown to a total of one hundred and forty vehicles at the end of 1907, has been run continuously on a mixture of equal parts of alcohol and gasoline, at an estimated saving of $60,000. The 'buses had been run a total of two and a quarter million miles on this fuel, and no erosion or pitting of the valves had been noticed. It appeared to be as effective as gasoline although there was some difficulty in starting the engines in cold weather, which was overcome by priming with gasoline. The engines heated less than with gasoline.

Within the last two years the automobile taximeter cab for public service has come into common use in leading European cities and is now being introduced rapidly in America. Between three thousand and four thousand are probably in use in Paris, London and Berlin, while New York will have more than one thousand by the time this appears in print. The taxicabs, as the little machines are called for short, are light, fast gasoline machines with landaulet bodies. The more typical cars built for this service are driven by either two-cylinder or four-cylinder vertical engines of from 8-10 to 12-15 horse power and have a maximum speed of about 18 to 20 miles an hour. They are short enough to be turned readily in an ordinary street

DELAHAYE FRENCH TAXIMETER CAB IN PUBLIC SERVICE IN NEW YORK.
Weight, without body, 1,300 lb.; capacity, five passengers; speed, 21 miles an hour; twin-cylinder vertical engine, 8-10 horse power; wheelbase, 101½ in., tread, 48½ in.; three-speed sliding gear transmission.

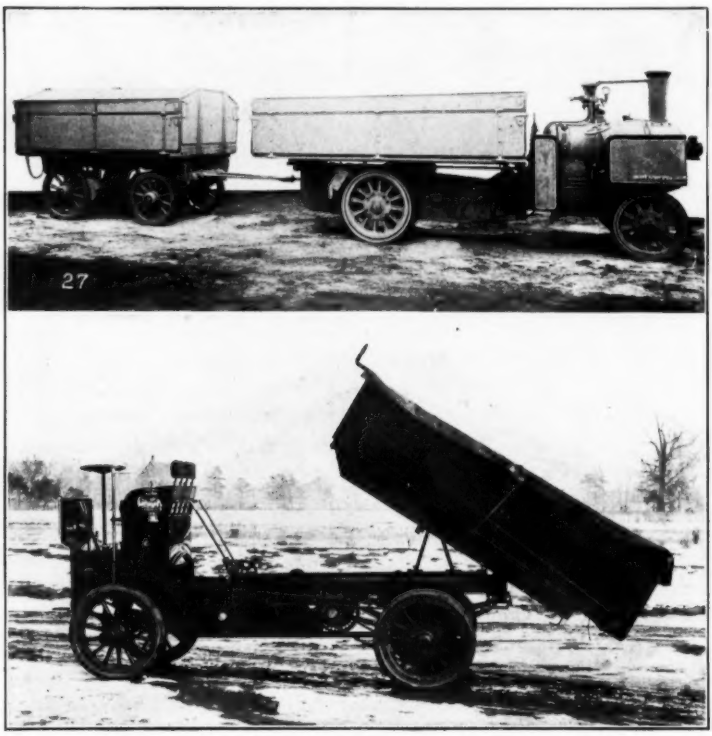
without reversing and will accommodate two passengers on the permanent rear seat and two others on folding inside seats. A fifth passenger can sit with the driver. Drive is by shaft to the rear axle and then by live axle or spur gearing to the rear wheels. A feature of all these cabs is their equipment with the taximeter, a foreign invention for automatically calculating, indicating and registering the amount of fare to be paid, the mileage traversed and other information needed by the operating company. The mechanism is driven by the road wheel through a flexible shaft when the vehicle is running and by clockwork when the car is waiting while engaged.

American manufacturers have rushed to put taximeter cabs in the field during the past year after observing the success that followed their introduction abroad and in New York. The first to produce such a vehicle designed throughout for this special and very exacting service was the Thomas company, whose cab is notable for the casting of all four cylinders of the 16-22 horse-power motor in a single block, with integral water jacket encasing the exhaust valves and pipe as well as the cylinders. Construction is simplified as much as possible

in the power plant in other ways, also, as placing inlet and exhaust valves all on one side of the cylinder heads and operating them by one camshaft, and by depending upon thermo-siphonic action for circulating the cooling water, as in the Renault cabs which are most extensively used in the European capitals.

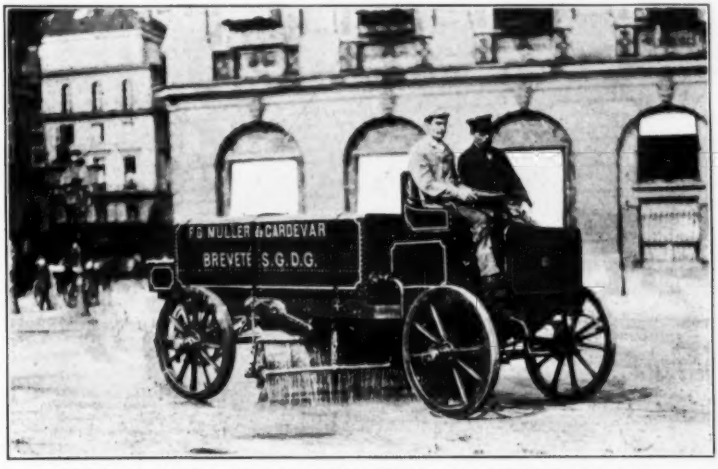
Motor Vehicles for Municipal Work.

Heavy steam and gasoline vehicles are used extensively by the street departments of a number of municipalities for special work such as garbage removal, street sprinkling, street sweeping, road building. The corporations of Liverpool and Chelsea, England, for example have had steam wagons and trailers in regular daily service for ten years and have increased the number several times. In a report on the performance of the Liverpool vehicles made by the engineer of the



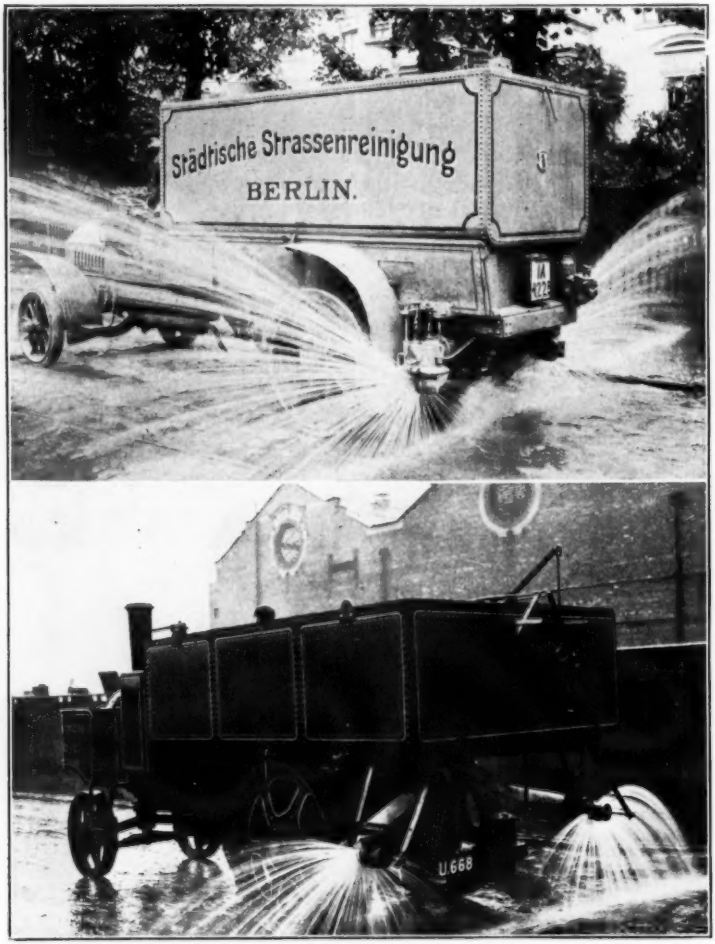
ABOVE, MANN'S STEAM SCAVENGING WAGON AND TRAILER; BELOW, KNOX (AMERICAN) 3-TON GASOLINE GARBAGE WAGON WITH TIPPING BODY.

department, he stated that they are used chiefly for collecting refuse, street sprinkling, and hauling crushed stone and other material used in repairing the streets, the vehicles having bodies of different types that are interchangeable so that a wagon which is used for sprinkling in summer can be employed in hauling materials during other seasons of the year. Some of the self-emptying bodies are built to tip to either side and others to tip to the rear. The steam wagons have a carrying capacity of 4½ tons. They are worked 20 hours a day, by two shifts of men, each wagon covering about 100 miles a week. The total annual cost of operation of each wagon is about $2,000, which represents a saving of 15 per cent over the cost of doing the same work with horses, as shown by the records that have been carefully kept.



EUROPEAN COMBINATION STREET-WATERING AND SWEEPING MACHINE.
Capacity of tank, 555 gal.; width of water distribution, 25 ft.; 12 horse-power combustion motor under driver's seat.

Municipal authorities in America have shown little interest in special motor vehicles for street work. Cincinnati, however, purchased four gasoline wagons for garbage disposal last year. These have tipping bodies mounted on standard Knox chassis of 6,000-pounds capacity fitted with double opposed air-cooled engines suspended horizontally under the frame. Tipping of the body is accomplished by means of a slide on the under side of the bed secured at the apex of a pair of short rods attached at their lower ends to two traveling nuts. These nuts move on a long rod with a slow-pitch thread



ABOVE, "N. A. C." 2-TON SPRINKLING WAGON USED IN BERLIN; BELOW, MANN'S (ENGLISH) STEAM-DRIVEN STREET-SPRINKLING WAGON.

The German wagon has a width of water distribution of 65 ft., uniform pressure being maintained by compressed air; capacity, 1,320 gallons; vertical four-cylinder engine of 18 horse power.

extending longitudinally of the frame and journaled at its ends. Bevel gears are provided at the front end of the rod by means of which the rod can be revolved in either direction by a transverse shaft driven from the engine crankshaft by chains and sprockets. There are two

special levers, one for engaging and disengaging the bevel pinions and the other for controlling a clutch between the crankshaft and screw mechanism so that the latter can be operated or not when the engine is running.

Steam, gasoline and electric vehicles have all been adapted to street sprinkling work. The Mann's sprinkler is a typical example of the English steam watering cart. Practically the entire vehicle is built of steel and iron, including the wheels and tires and all parts of the body. The body is interchangeable with other types. A very different class of German watering wagons is in service in Berlin where it has shown its superiority to the older forms of sprinkling apparatus. The tank and spraying apparatus, which are of a type used in many Continental cities, are mounted on a chassis of the standard type having pressed steel frame, solid rubber tires and propelled by a 16-18 horse-power internal-combustion engine of the four-cylinder pattern. The tank has a capacity of 1,320 gallons and is made air-tight. By means of an air pump driven by the gasoline engine, a constant pressure can be maintained on the water whether the tank is full or nearly empty and the sprinklers can throw the water to a distance of 32½ feet to either side of the center. The tank is divided vertically into three compartments by bulkheads to prevent hammering of the water when the wagon is in motion. A hand-wheel similar to the steering wheel regulates the distance to which the water is thrown, and the water can be shut off from either of the inner or outer sprays at will. Tests made in Berlin, Hamburg, and Kiel showed that a distance of 1½ kilometres could be sprayed the full width of 65 feet from one filling of the tank, showing a great economy notwithstanding the high first cost of the machine and the fact that a special attendant, in addition to the driver, is required to manipulate the apparatus.

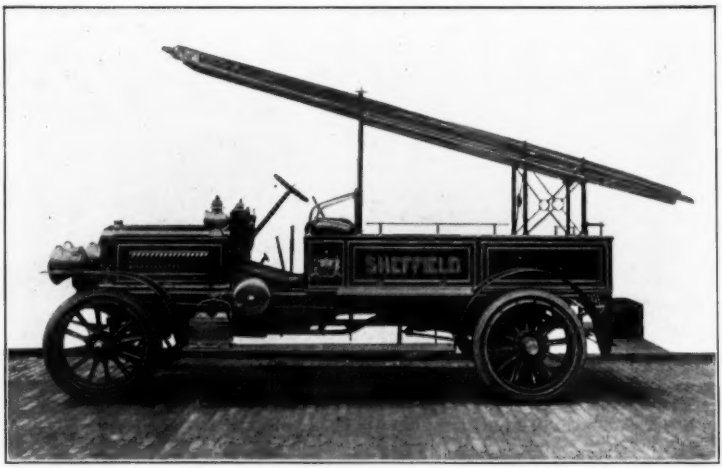
In Boston and Worcester, Mass., sprinkling tanks mounted on gas engine chassis are in use, while Hartford, Conn., uses electric sprinkling wagons.

A combination street sprinkler and sweeper invented by F. G. Muller de Cardevar has been given numerous tests in Paris, London and other cities. It is driven by a 12 horse-power gasoline engine carried under the driver's seat. The tank holds 555 gallons and has a discharge pipe under the wagon besides a pair of spray distributors at the rear. A revolving brush under the center of the vehicle is independently driven by the engine, and is adjustable by levers at the side of the machine. Water discharged from the pipe in front of the brush lays the dust. The rear sprays can sprinkle a path 25 feet wide.

COLUMBIA ELECTRIC CHEMICAL AND HOSE TRUCK IN USE IN HOPEDALE, MASS.

Self-Propelled Fire Apparatus.

In no other field of service are the speed and power of motor vehicles so obviously of advantage as in fire fighting in cities. Fire chiefs and fire commissioners have been quick to recognize the possibilities of motor fire apparatus in arriving at the scene of a fire with the least possible delay, and also to appreciate the fact that there is economy in using a power which consumes no fuel or feed while standing in the station house. As a consequence such apparatus has



ARGYLL EXTENSION LADDER TRUCK USED BY SHEFFIELD (ENGLAND) FIRE DEPARTMENT.

been installed within the last year or two in many cities in the United States and Canada and in Germany, England, France and Italy. Special attention has been given to the development of combination chemical and hose wagons, which are made in a variety of types in both gasoline and electric classes. The Columbia electric combination truck used in Hopedale, Mass., is a fair example. It is equipped with a pair of copper tanks under the seat, with ladders, chemical hose and standard water hose, hand extinguishers, nozzles, and a complement of hand implements. With batteries already charged, it needs only the insertion of a plug switch and movement of the controller handle to get under way. Its superior speed enables it to arrive at a fire well in advance of the steamer and to have the chemical stream trained on the blaze and the water hose stretched before the steamer has coupled to the hydrant.

WEBB AMERICAN GASOLINE FIRE ENGINE.

Rotary water pump mounted on 40 horse-power touring-car chassis and driven by vehicle engine.

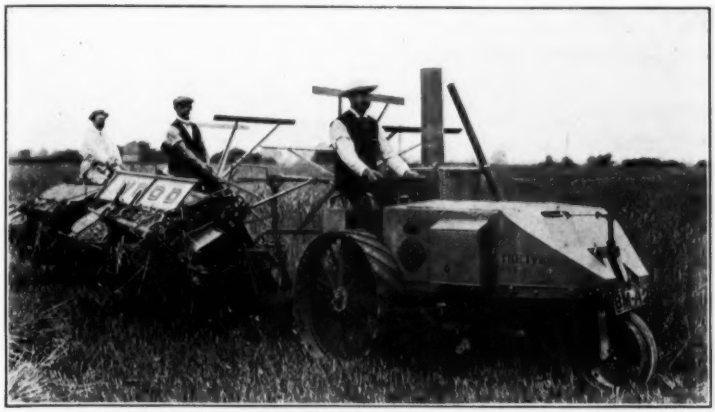
The Knox gasoline combination truck which has been supplied to a number of cites and which has a body and equipment very similar to those of the Columbia, is equipped with two 25-gallon chemical tanks and 1,000 feet of water hose. It carries ten men and has a maximum speed of fifteen miles an hour.

For English and German fire departments the foreign motor-car builders have evolved various types of extension-ladder and scal-

ing-ladder trucks, the European peoples evidently looking upon the saving of life as a matter of first consideration. The gasoline ladder wagon supplied to the Corporation of Sheffield by Argyll Motors, Ltd., is a fair example of the British practice. The chief officer of the Sheffield Fire Department reported last December that this ladder truck had attended more than forty fires without a hitch and was running splendidly.

The most recent development in fire apparatus is the self-propelled pumping engine. A number of these have been produced in the United States by at least half a dozen different builders. A notable one is the Webb pumping engine brought out last fall in Joplin, Mo., and given severe tests. The pump is mounted on the chassis of a Thomas touring car of 40 horse power for which a special body was designed. The rotary water pump is bolted to two cross members of the frame and can be connected through spur gearing with the transmission of the car by means of a special lever. The shifting of the pump gear into mesh upon arrival at the scene of a fire automatically cuts off the radiator from the engine which is then supplied with cooling water by a separate feed from the rotary pump. With the small pump used on the experimental engine a stream of water was thrown over a three-story factory building in tests made before officials of the Buffalo Fire Department.

A pumping engine along lines similar to the foregoing has been built in the shops of the St. Louis Car Company after designs by W. A. Wagenhals. A rotary pump with capacity of 600 gallons a minute is mounted on the rear end of the chassis of a 50-horse-power American Mors four-cylinder touring car capable of a maximum speed of sixty-five miles an hour. The pump is geared direct to the engine by a single shaft carrying a gear with which a sliding pinion on the transmission shaft between the clutch and gear box can be thrown into mesh when the regular gear shift lever is in neutral position. The engine is self-starting by means of a drum on the end of the crankshaft and weighted cable which is automatically released when the alarm sounds. To insure certainty of action a small quantity of gasoline is automatically introduced into the cylinders at the same time. Vibration of the body on the running gear when pumping is prevented by means of two vertical screw rods that can be screwed down quickly through blocks on the sides of the frame until their lower ends rest upon the front axle and take the load off of the springs. In tests before representatives of the St. Louis Fire Department this pumping engine has thrown a 1½-inch stream to a

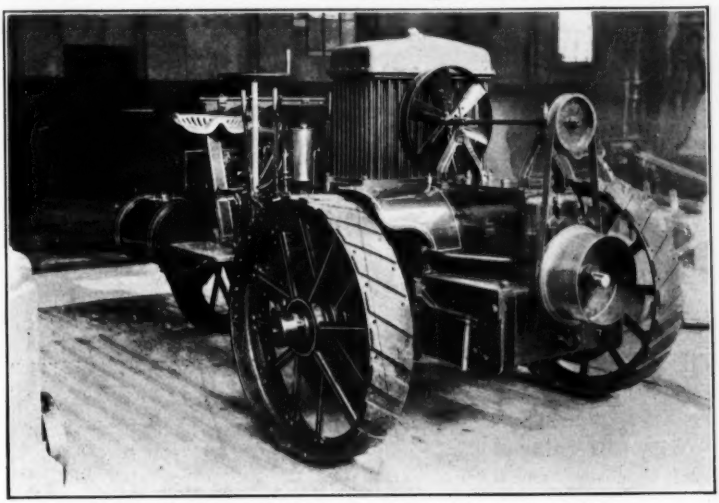


IVEL GAS-ENGINE AGRICULTURAL TRACTOR HAULING TWO REAPERS.
Weight, complete, 3,584 lb.; engine, double-opposed, 18-20 horse power, disposed longitudinally; consumes gasoline, kerosene, or alcohol.

horizontal distance of 210 feet with a pressure of 150 pounds per inch.

Motor Tractors for Agricultural Work.

The horse is being driven even from his last stronghold on the farm by the motor vehicle, which is proving far more efficient in plow-



SAUNDERSON 50 HORSE-POWER GAS-ENGINE FARM TRACTOR.

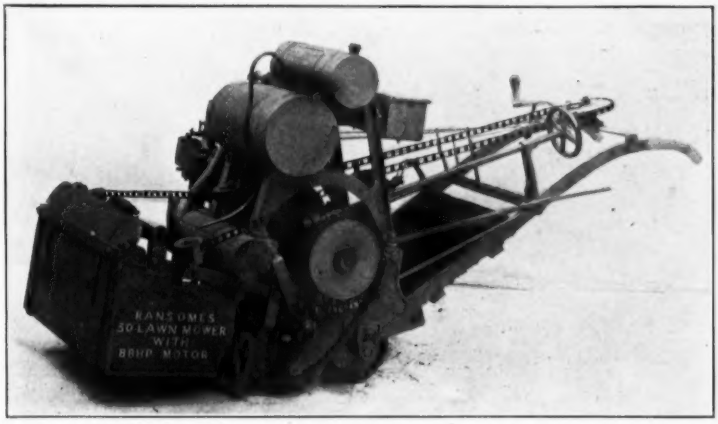
ing, harrowing, reaping, and threshing. Curiously, England appears to have made more progress in the development of the small internal-combustion engine farm tractor than America, although thousands of small stationary and portable gas engines are used for feed cutting, grinding, churning, pumping, and sawing wood on farms throughout the United States and steam traction engines are common. The first of the successful light gas-engine tractors was the Ivel, brought out in

BARFORD & PERKINS WATER-BALLAST MOTOR ROLLER.

England in 1902. This can be operated on gasoline, kerosene, or alcohol and has won twenty-six gold and silver medals in plowing matches and other competitions before agricultural and other societies in different countries. Complete, the machine weighs 32 hundred weight (3,584 pounds). Motive power is supplied by an 18-20 horse-power double-cylinder opposed engine disposed longitudinally in the frame and protected by a metal cover. A pulley is fitted for stationary work such as threshing, grinding, and driving a dynamo. Hauling a three-furrow plow, the tractor has plowed 6 acres in 9 hours to a depth of 7 inches on a consumption of 20 gallons of gasoline or kerosene and one gallon of lubricating oil. One user, after two years' experience, claimed to have done with it daily on an average as much plowing as he could do in the same time with three teams of three horses, three men and three boys—that is, 2¼ acres of heavy soil to a depth of 6 inches. With one 6-foot reaper and binder attached, 2½ acres of grain could be cut in an hour on a consumption of 2¼ gal-

lons of gasoline and one pint of oil. Two small binders can, however, be hauled on suitable ground. Another user found that it would easily drive a 60-inch double-blast threshing machine and at the same time a straw trusser. More powerful tractors are built for plowing and reaping on a more extensive scale, such as the 50-horse-power Saunderson Universal motor, also built in England. Like the Ivel, it is a three-wheeled machine, but it drives by a pair of front wheels and is totally different in construction and appearance, the engine standing vertically between the front wheels. The builders are now bringing out two smaller tractors of 20 and 30-35 horse power which will have four wheels and drive by the rear pair.

Even lawn mowers and turf and road rollers are now operated by gas engines. Water-ballast rollers driven by one and two-cylinder vertical engines using either gasoline or kerosene as fuel are built in England for light and heavy work. They are made in a variety of models for special purposes and range in weight from 2½ to 8 tons. empty. When filled the weight is increased from ½ ton to 1 ton. In addition to filling their special mission as rollers, they can be employed as stationary engines for a variety of work.



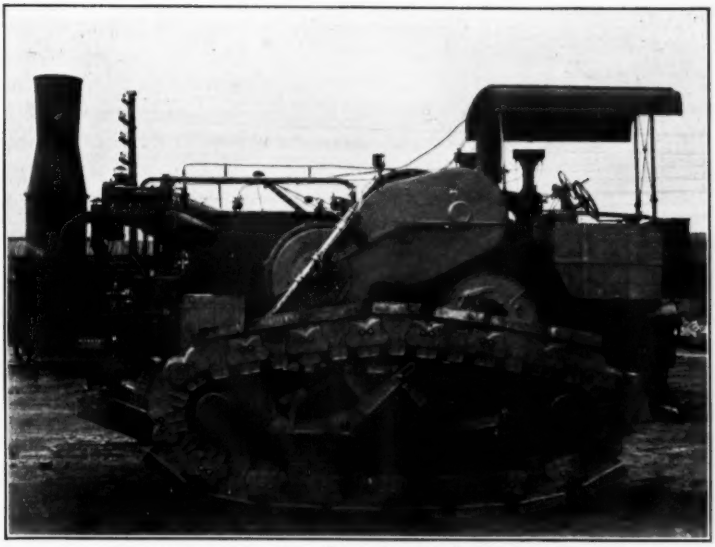
RANSOMES 30-INCH LAWN MOWER WITH 6 HORSE-POWER MOTOR.

The Ransomes English lawn mower has a 30-inch revolving cutter and is driven by a 6-8 horse-power engine. The operator walks behind, guiding the machine by a pair of downwardly curved handles and emptying the hopper in front by the crank and long chain. The end doors of the hopper are hinged at the top and are pushed open by the cut grass as the chain moves a diaphragm that slides transversely on a rod above the hopper. The engine is on the right side of the

machine, where it stands in a vertical position and drives a flywheel in the center of the machine. Rods for controlling spark and throttle are carried back to small levers within reach of the operator. The propelling roller is driven by a chain with suitable reduction and the cutter is run at high speed by a similar chain geared up by a large sprocket. The radiator is at the rear between the shafts of the guiding handles, while the muffler is in front where the gases will not offend the operator.

The Coldwell American lawn mower, built in Newburgh, which is used for cutting the grass on the White House grounds in Washington, and on large private estates, has a comfortable seat on which the operator sits, steering with a tiller. The seat is on a platform supported at the rear end by an extra roller. Two sizes of these machines are built, one having a cutter 35 inches wide and the other a 40-inch cutter. The former weighs 1,200 pounds and is driven by a single-cylinder 4-horse-power engine, while the latter weighs 1,500 pounds and has a twin-cylinder 8-horse-power engine. The over-all length of both machines is 6½ feet and the driving rollers are 15 inches in diameter. The engine is water-cooled, the radiator standing vertically in front. When not in use, the cutter can be raised high above the ground.

FRENCH ARMORED MILITARY CAR WITH RAPID-FIRE GUN.



HORNSBY MILITARY "CHAIN-TRACK" OIL ENGINE.

Vehicles for Military Service.

Although many motor wagons have been especially constructed to meet the requirements or the approval of the war offices of the European nations and the United States, the two machines here illustrated are probably the most unique. One is an armored fighting machine which conceivably would be very effective in dealing with the street mobs that give concern to the military of Continental and some Asiatic cities. A rapid-fire gun is mounted in the rear and the barrel projects from a turret on the roof. The car can be entirely shut up for complete protection of driver and gunner, and all vital parts, including the radiator, are protected. The driver enters by a door at the left of the seat and the gunner by a door in the rear. On either side is carried a metal trough on which the wheels can run in crossing narrow trenches, ditches, and holes. Power plant and driving mechanism do not differ materially from customary touring-car practice.

The very latest production for military work is the Hornsby "chain track" tractor for hauling transport wagons and drawing guns into position over ground where no roads or railroads are available. The invention is essentially an oil-burning internal-combustion traction engine whose wheels run on endless tracks formed by chains. These chains are made of a number of feet or bearing blocks linked

together with intermediate locking links so that they are flexible in one direction to pass around sprocket wheels at either end but present a rigid arc to the road. The center pair of wheels on each side are weight-carrying wheels. The rear wheel is the power wheel, whose sprockets engage the chain and force the vehicle along on the chain tracks, at the same time lifting the chain at the rear and carrying it forward over an idle wheel above the center wheels. Some remarkable results have been obtained at Aldershot with an engine equipped with this chain-track device. Obstacles that would be impassable to the ordinary traction engine or even to horse-drawn wagons have proved no barrier to it. It has descended and ascended the clay banks of a stream having an inclination of 1 in 2 and 12 feet high, has traversed deep loose sand and drawn a loaded trailer also fitted with chain tracks, and has crossed bogs in which horses became hopelessly mired. In crossing a narrow ditch the engine advances from one side until it projects nearly half way beyond, when it plants the "feet" at the front on the opposite bank and proceeds without descending to the bottom of the ditch.

Promise of the Future.

It has been possible in these articles to give only a few typical examples of important classes of motor vehicles for various industrial purposes, yet they will suffice to indicate the wonderful variety of work to which such self-propelled vehicles can be applied with economy and efficiency. They can do certain kinds of work that no other power or vehicle can do as quickly, well, and cheaply. Engineers are devoting much effort to solving the fuel problems, so that it may be expected confidently that in a very few years at most it will be possible to operate heavy commercial vehicles with entire satisfaction on kerosene, denatured alcohol, and producer gas. Already experiments in the application to the heavy motor car of gas producers using coal or coke have met with some success that augurs well for the future, and in experimental work in the shop a 15-horse-power stationary engine has been run at full load continuously from a portable producer plant weighing only 180 pounds. This experiment, carried out by M. Louis Fornas, a Parisian engineer, showed a consumption of slightly more than one pound of coke and about one quart of water per horse power per hour.

It is evident, then, that while there is an excellent foundation in many fields upon which to work, industrial motor-vehicle development is still in comparative infancy and there is ample opportunity for study and original work.

MEANS AND METHODS FOR HEATING THE FEED WATER OF STEAM BOILERS.

By Reginald Pelham Bolton.

I. GAIN OR LOSS BY FEED HEATING.

In a series of three articles, of which this is the first, Mr. Bolton makes a careful examination of the actual economy of feed-water heating, working out the heat balance in a most interesting manner and presenting, in the later parts of his discussion, very useful and suggestive diagrams showing the results or indicating arrangements with various dispositions of the feed-heating equipment. The second part or his series will take up the use of live steam, and the third will examine the economy of heating by used or waste steam.—THE EDITORS.

THE ad-heating of feed-water is a subject of concern to steam users, and the interest aroused in the subject of late years has brought about the development of a number of ingenious appliances and methods, some of which have proceeded beyond the point of the utilization of waste or rejected heat for this purpose and have entered upon the diversion of otherwise useful heat, raising the question as to how far such a process can be desirably or economically carried.

Bold assertions are made to the effect that the ad-heat of feed water brings about an increase not only in capacity but in efficiency of the boiler, and the credit for indirect advantages such as the reduction of strains by large inequality of temperature, and the elimination of deleterious substances, is assumed to be applicable to additions of temperature which require the use of otherwise usable heat.

The question as to how far the process may be carried with economic effect, and where the dividing point occurs at which loss results instead of gain, is one that has been to a great extent lost to sight, as is the fact that if any useful purpose can be served by waste heat, capable of showing an advantage superior to that of ad-heating the feed water, its use in the latter process may result in reduced instead of increased economy.

Tabulations frequently published in the interest of appliances for ad-heating feed water purport to show gains proportioned upon the relation which the heat thus added bears to the difference between the

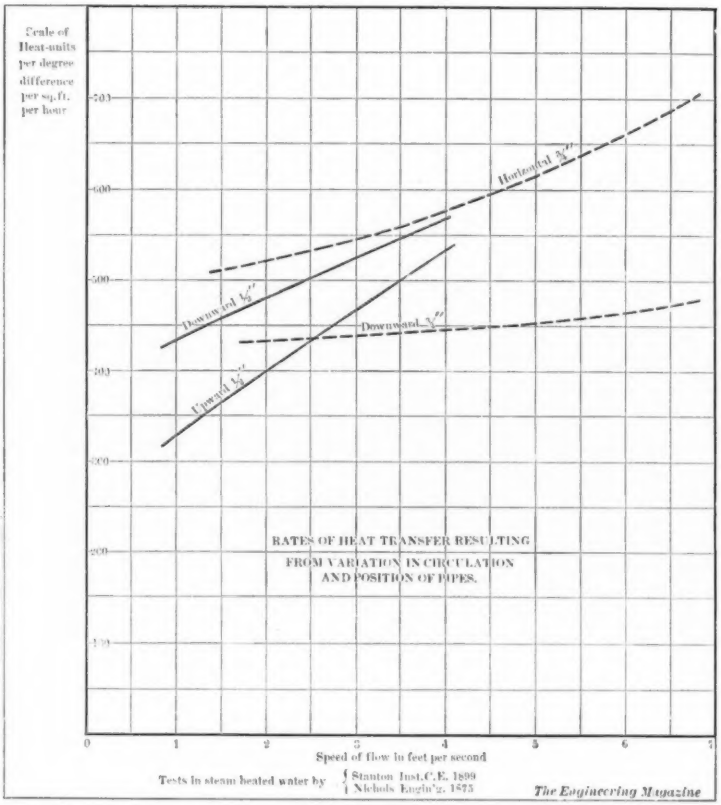


DIAGRAM OF VARYING RATES OF HEAT TRANSFER RESULTING FROM VARIATION IN CIRCULATION AND POSITION OF PIPES.

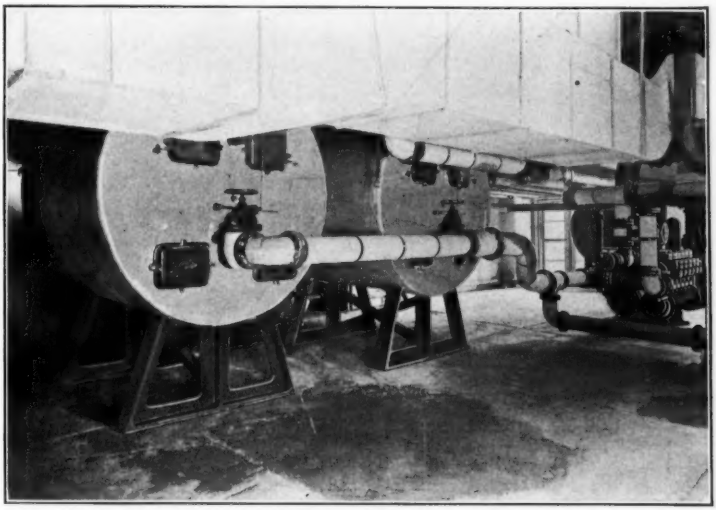
feed, not so heated, and the heat in the steam at boiler pressure. This relation is brought out by the rule:

$$\frac{h^2 - h^1}{H - h^1}$$

in which
H = heat in steam.
h^1 = heat in feed water.
h^2 = heat in feed after ad-heating.

The rule is commonly extended to the assumption that the ad-heat, being a contribution which is effected outside the boiler to the work of steam raising, will be represented by a corresponding reduction in the fuel for an equal output in steam.

These computations, however, are reliable only to the extent of the proportion which the ad-heat bears to the total difference between feed water and steam, and do not take into account the effect upon the boiler and furnace operation which the alteration of that difference of temperature may bring about.



INSTALLATION OF WEBSTER HEATERS IN THE POWER PLANT OF THE WANAMAKER BUILDING, PHILADELPHIA.

Showing two of the four 1,500 horse-power heaters. Warren Webster & Co., Camden, N. J

It does not follow that the mere introduction into a boiler of its feed water at a higher degree of temperature will result in a commensurate reduction of the fuel, nor in a proportionate increase in the output of steam, unless there be some established condition in either the furnace or the boiler, and their relation to one another, which is to be benefitted by the lessening of the difference between the entering feed and the departing steam. In fact, unless the heat-receptive qualities of the one, and the heat-imparting ability of the other, are very nicely adjusted to the new conditions thus established, the increase in temperature may cause a less efficient transfer of heat from the fuel to the boiler contents.

In every form of boiler there is a rate of circulating flow of the water which, in combination with a certain difference between the external temperature and the average internal temperature, will result in the best results in transfer of heat.

The lower the temperature of the introduced feed, the greater will be the average difference between the flame and the water, and the greater the rate of heat transfer. If the ad-heat in the feed is to overcome this condition and show superior results, it must be by so affecting the process that the speed of the water over the heated surfaces is accelerated to an extent sufficient to restore the rate of transfer per unit of surface.

It will perhaps seem, to some who have not given this view of the subject much detailed attention, an extraordinary proposition that the increase of feed temperature, with a fixed furnace condition, may result in a reduction of efficiency and even of the output of a boiler; but with certain boilers, under equal conditions, this is the case, as shown by the following records of tests in which a difference of feed temperature existed.

H. M. S. SHELDRAKE.

Water-tube Boilers.	Official Trials.			
Feed temperatures	115°	114°	70°	70°
Gas temperatures	550°	600°	550°	600°
Coal per sq. ft. of grate	20	26.19	22.5	24
Evaporation, f. & a. 212°	11.6	11.52	12.72	12.12
Efficiency, per cent	74.3	73.5	81.2	77.4

STEAMSHIP CRESCENT CITY.

Water-tube Boilers.	J. F. Hayes	W. D. Hoxie.
Feed temperatures	243°	181°
Coal per sq. ft. of grate	20.16	20.83
Evaporation per lb. of coal	9.69	9.72
Evaporation, f. & a. 212°	9.93	10.62

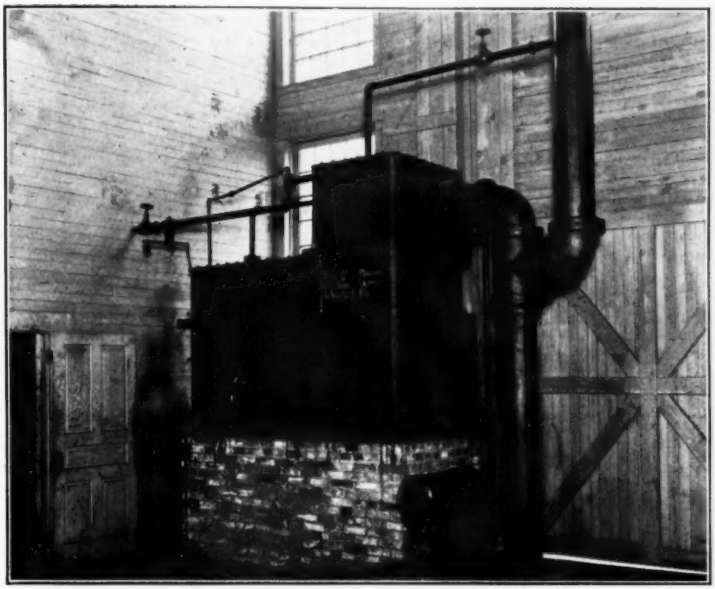
TESTS ON ONE HORIZONTAL RETURN TUBULAR BOILER.

	Prof. J. A. Denton.	
Feed temperature	199°	176°
Gas temperature	529°	550°
Combustible per sq. ft. grate	12.3	12.17
Evaporation per lb. combust	11.13	11.18
Efficiency, per cent	60	68.7

2 TESTS VERTICAL WATER-TUBE BOILERS.

	G. H. Barrus.	Prof. Wagner.
Feed temperature	123°	38.6°
Steam pressure	63.9	99.
Superheat	.....	3.7°
Gas temperature	495	312.7
Coal per sq. ft. grate	19.79	21.33
Evaporation per lb. coal	7	7.255
Efficiency, per cent	66.1	70.5

The mere increase of temperature of feed water therefore does not necessarily represent a gain in fuel; but, if it be accompanied by an equivalent rate of increase in the speed at which that feed water passes over the heat-transferring surfaces, then its value may be realized in coal saved.



HARRISON SAFETY BOILER WORKS HOT-PROCESS SYSTEM OF WATER PURIFICATION, CRUCIBLE STEEL COMPANY OF AMERICA.

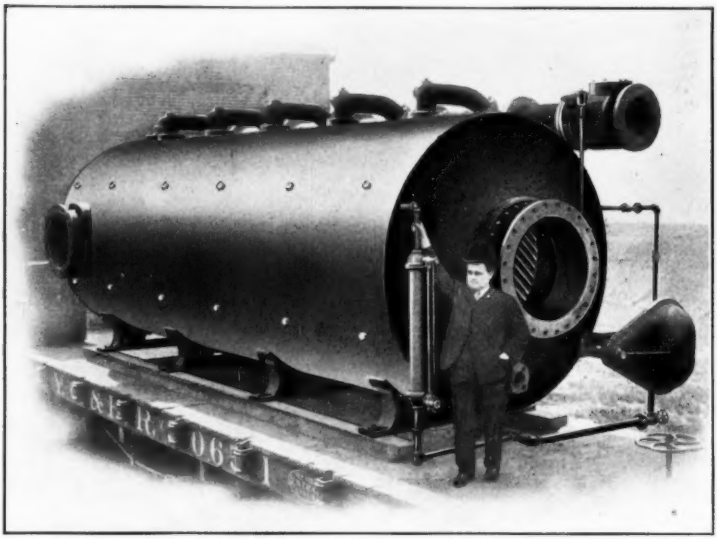
Advantage is taken of the necessary heating of boiler feed to precipitate carbonates in an open heater, thus dispensing with the use of lime and soda. A single reagent then removes sulphates and chlorides, thus reducing complexity of parts and amount of attention needed for operation. The apparatus performs all the functions of an open heater.

Several experimenters have demonstrated the effect of increasing velocities with fixed differences between the water inside a tube and steam outside the same tube, and have shown that this varies considerably with the position of the tube, its size, its character, and the direction of flow, as would be the case with the numerous forms of boiler constructions, the positions and sizes of their tubes.

Reported gains in economy or fuel reduction by the use of increased temperature of feed water are thus traceable to internal contributory causes, the chief feature of which is some acceleration of the speed of travel of the water, or in other words, its circulation over the heat-transferring surfaces. And it will follow that in the case of boilers in which the design and furnace conditions are such as to have already established the best conditions of flow and of heat transfer, no gain, but perhaps a loss, will result; while a boiler in which a more active circulation may be promoted by the heated feed,

and which may thus absorb some of the heat of the fire it has hitherto failed to receive, will show a gain in output, and sometimes in economy.

Of such forms of boilers as may receive special benefits, the internally-fired types are probably most conspicuous, because the large amount of water they contain, and the location of much of their contents below the fire level, renders them particularly liable to inactive or partial circulation, and a higher temperature of feed water introduced at a low level will promote an active disturbance of the dead water, and start an upward current over the heated surfaces.

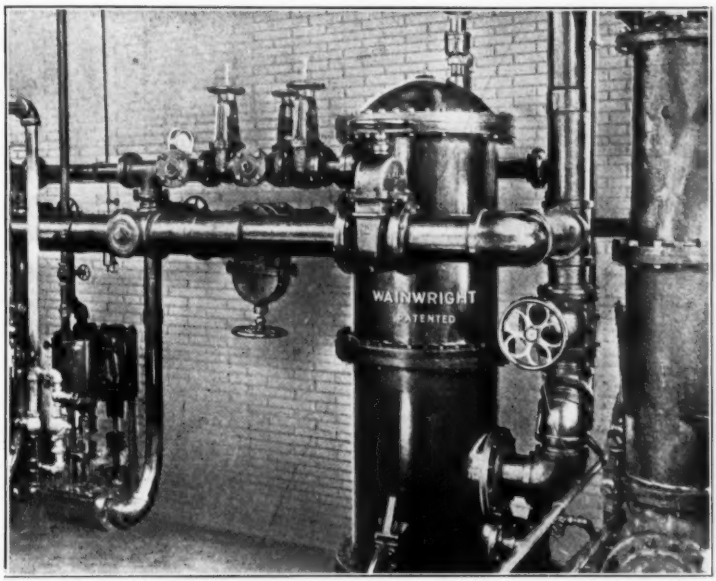


A 20,000 HORSE-POWER HOPPES FEED-WATER HEATER.

The water flows over trough-shaped pans, overflowing the edges and following the under side in direct contact with the exhaust steam. The scale-making solids are deposited on these pans, especially on the under side. The flow of water to each tier of pans is controlled by the orifices from the main feed line. This system of distribution makes possible the use of large units and the operation of two or more heaters in parallel. Hoppes Manufacturing Co., Springfield, Ohio.

A similar effect may be brought about in the locomotive pattern, by aiding a more rapid circulation of the water from the bottom of the fire-box shell space, though it is more likely that any gain in this class of boiler is due to the following cause.

An increase in feed temperature, with proper appliances, conduces



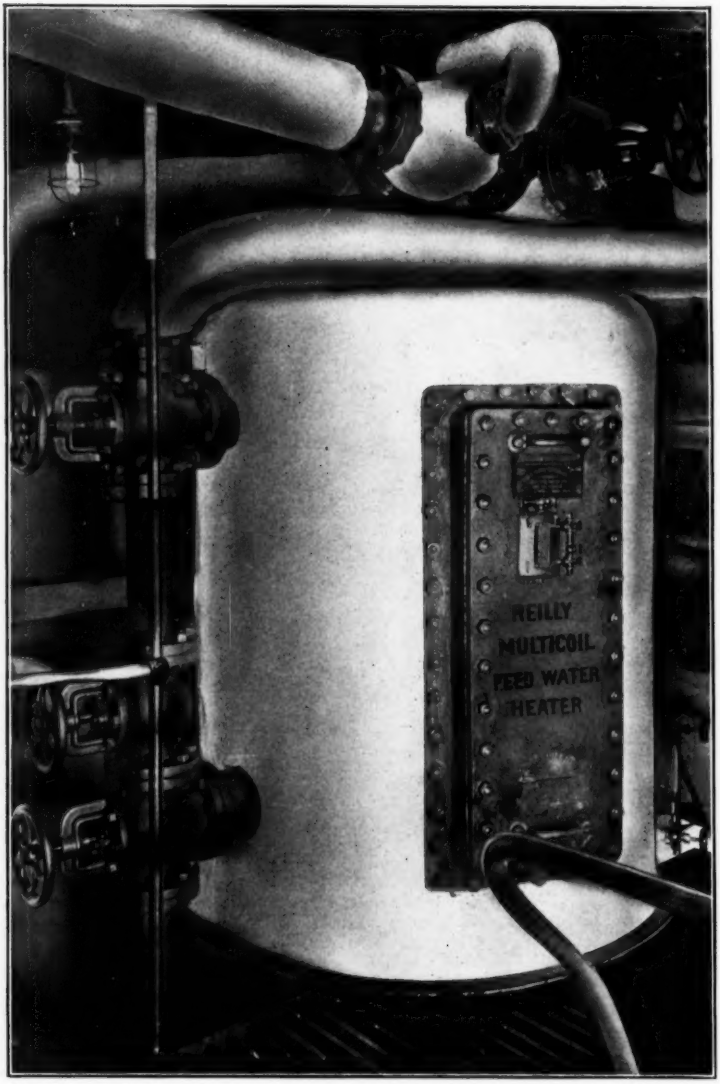
A 2,000 HORSE-POWER WAINWRIGHT HEATER INSTALLED IN A NEW ENGLAND FACTORY.

Alberger Condenser Co., New York.

to the more complete separation, from the feed-water, of the deleterious and disturbing element of contained air and gases, especially where the fluid is drawn from a fresh supply, as is the case in non-condensing plants, locomotives, and general land practice. My own observations of the internal performance of locomotive pattern boilers, made and described in 1891, brought under my vision the operations of bubbles forming upon the surface of the heated plates, the action of which is an alternate expansion and contraction, prior to their release from the plate, evidently using up heat in the kinetic process, and meanwhile occupying the heat-transferring space which should have been covered with water. If by any deficiency in circulating arrangements such a bubble-covered surface is not relieved of its incubus, the result must be very largely to affect the efficiency of the heated plate as an agent of heat transfer.

The effect is cumulative:

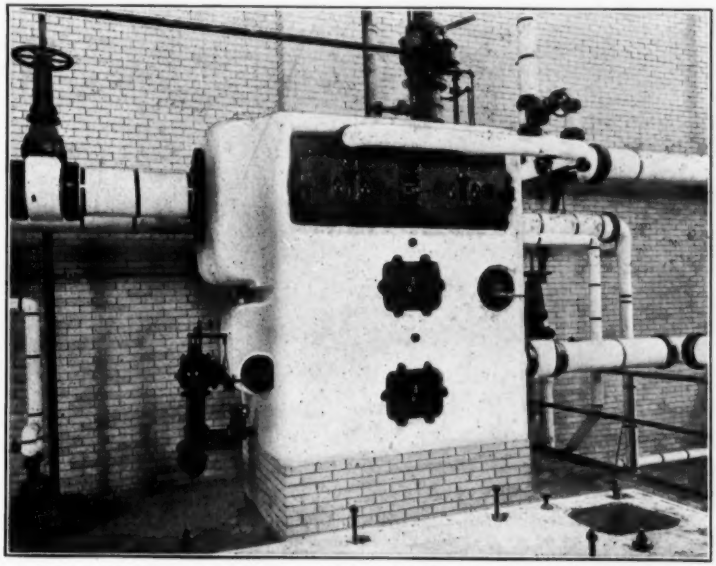
"Small bubbles of air expelled from the water on boiling attach themselves tenaciously to the heating surfaces. The oxygen therein commences to attack the metal—pitting follows—forming ideal resting places for the air-bubbles to collect in, and presenting increased area for attack."



INSTALLATION OF THE REILLY MULTICOIL FEED-WATER HEATER IN MUNICIPAL FERRY BOATS, N. Y. CITY.

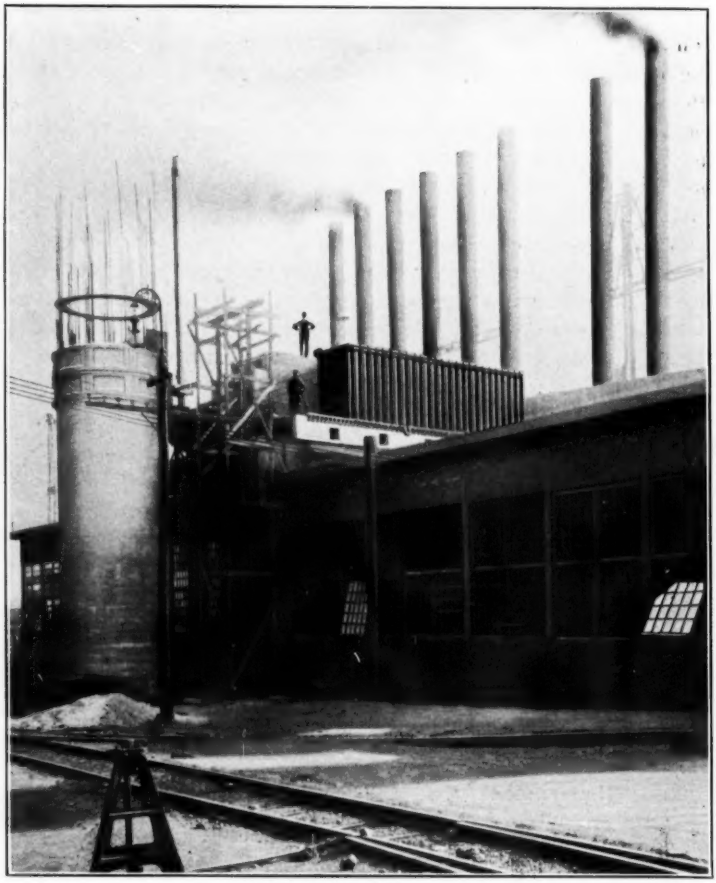
The exhaust steam from the auxiliaries is used, and gives a feed temperature of 220 degrees. The heater is provided with magnesia covering. The Griscom-Spencer Co., N. Y.

The locomotive boiler, when in practical use, is subjected to a continual shaking and mechanical motion of its contents, which is highly beneficial in detaching from its heated surfaces the bubbles that its constant supply of fresh and aerated water is bringing into existence. It is explicable why a locomotive boiler, when removed from active service and placed in a stationary position, will "never make anything like the same quantity of steam, nor with the same efficiency that it did on the rails," even with ad-heated feed, for, over and above its loss of the mechanical motion above referred to, its chimney work becomes radically different, and in place of its originally designed induced draft, automatically increasing with the demand for steam, it is provided with an unvarying draft suited only to the burning of a certain amount of fuel upon its rather restricted grate area. The rate of steam production in the locomotive boiler affects very considerably the speed of circulation of the contained water, and a reduction of fuel consumption is followed by a reduction in steam output, with reduced circulation and resultant fall in economy.



COCHRANE HEATER AND RECEIVER, PACKARD MOTOR CAR COMPANY'S POWER PLANT.

The open heater utilizes the exhaust steam to preheat the boiler feed, and conserves the steam so used. The Cochrane type acts as a receiver for all returns and drips, skims and filters the feed water, and removes carbonates precipitated by heat.
Harrison Safety Boiler Works.



STURTEVANT ECONOMIZERS, PLANT OF THE AMERICAN STEEL & WIRE CO., WORCESTER, MASS.

If, in boilers affected by the foregoing conditions, as internally-fired boilers are, a system of feed supply be introduced by which, in company with a higher temperature, the air and gases therein will be wholly removed, a beneficial result may be due as much to one cause as the other; and it is to be noted that such a removal of the air-gases may be effected by the use of suitable apparatus without a greater degree of heat than is found in exhaust steam.

An incidental advantage which may be secured by a higher degree

of heat may be that of thoroughly clean plates, free from deposition of scale, and such a relief to the heat-transferring surfaces may even justify the cost of utilizing high-pressure steam, or of burning otherwise unnecessary fuel to produce, in the live-steam purifier or the economizer, that temperature at which the scale-making materials are separable from the feed water.

Heating by Waste Gases.

The value derivable from the addition of heat to feed water prior to its introduction into steam boilers has been a good deal confused by assumptions that the heat so added increases the economic performance of the boiler, and it has consequently led to arrangements for increasing the temperature of the feed water by methods which involve a sacrifice of otherwise useful heat.

The addition of heat to the feed supply of a boiler does not, however, justify the application thereto of heat which can be utilized to greater advantage in other parts of the operation of the apparatus, nor does the mere addition of heat in the feed supply add to the efficiency of the boiler as a heat-transferring apparatus, though it may indirectly affect the result by improving certain interior conditions.

Thus, the heat in the gases leaving a boiler and entering the base of a chimney is commonly regarded as an entirely waste product, whereas if the fuel be properly burned, and if the operation of the boiler be such as to release the products of combustion with only that amount of heat necessary to produce the effect of levitation in the chimney, the gases are really occupied in effecting useful work by the production of necessary draft, which would otherwise have to be brought about by some expenditure of power.

The performance of the combination of a furnace, a heat receiver, and a draft producer, should be credited with as much of this heat in the fuel (over and above that which may be absorbed by the boiler) as may be required to produce and maintain the air draft upon which the action of the furnace depends; and were this commonly done, a much better understanding would probably prevail upon the subject of furnace and boiler relations.

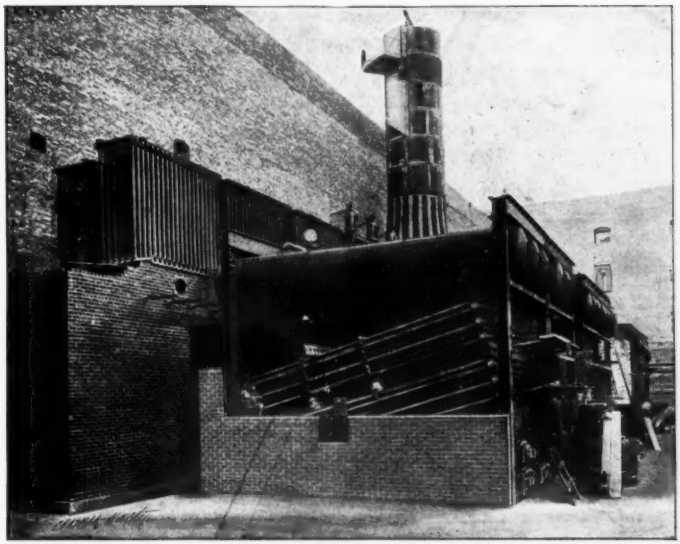
Modern combinations of steam-raising apparatus now commonly include an extension of the steam portion of the boiler in the form of superheaters, and these, under certain defective furnace conditions, may be extremely effective and yet be acting merely as a means of making up some discrepancy between the heat in the furnace and the absorbing capacity of the boiler. Methods applied in other ways to

bring about a due relation would show equally beneficial effects, in heat delivered by the boiler.

Similarly, the economizer, which is really a surface feed-water heater, placed in the line of passage of the gases passing from a boiler or boilers, is an effective appliance for the transfer of the heat in the gases to the feed water and has the advantage of a considerable difference in temperature between the two elements. But in cases where the gases are unduly heated, the economizer becomes a practical extension of the boiler, which is deficient in capacity for transferring the heat generated in the furnace to its contents. In other cases, where unsatisfactory furnace conditions result in an excessive volume of gases, the economizer becomes a partner of the furnace, breaking up and utilizing, more effectively than would an increase of boiler surface, the unduly large travelling body of heated gas given off by the furnace. In either case, the economizer is operating as a corrective of a defective condition in the furnace and boiler combination, which need not properly exist.

Further, in cases where part of the heating of feed-water could be economically effected by waste heat discharged from the steam appliances, it is manifestly an economic error to be doing the whole of the work in an economizer, if any other means exist by which the

STURTEVANT ECONOMIZER, AT WORKS OF THE INTERNATIONAL PAPER CO., HAMILTON, OHIO.



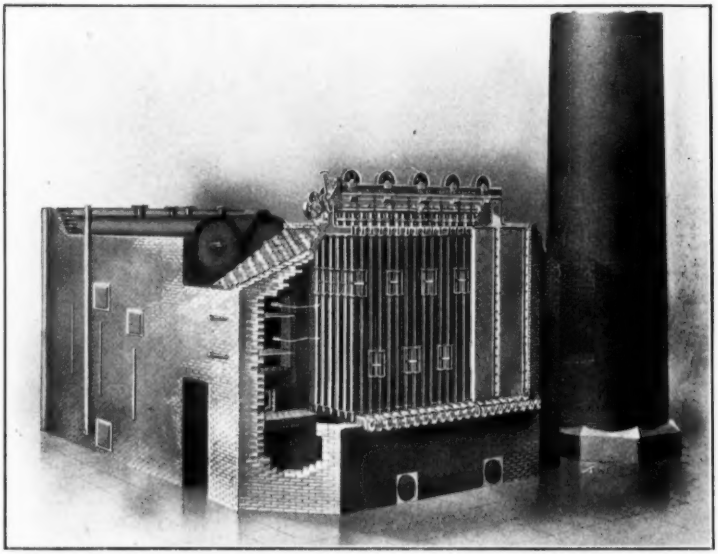
GREEN FUEL ECONOMIZERS IN AN ELECTRIC LIGHT AND POWER COMPANY'S PLANT.
The Green Fuel Economizer Co., Matteawan, N. Y.

surplus heat in the gases of combustion can be economically reduced, or put to use in improving the conditions of combustion.

In a multitude of such cases the economizer has shown its ability to make a more or less effective use of the established deficiencies, but its true value comes into prominence when it is adapted to utilization of heat absolutely unnecessary in the general functions of the apparatus. In combination, therefore, with mechanical draft, which corrects furnace conditions and properly proportions the air supply and resulting gas volume, the economizer finds its proper justification. In further combination with air-heating apparatus, by which the surplus heat in the gases may first be utilized to pre-heat the air supply to the furnace, although the process may leave less material with which the economizer may deal, and less to be accomplished by its use, it is then dealing with, and usefully utilizing, a true waste product.

The air supply to a furnace being at 60 degrees Fahrenheit, and the fuel being Pennsylvania anthracite at 12,800 heat units per pound, the theoretic quantity of air for combustion is 12.79 pounds per pound of fuel. Under good conditions of draft, the air supply would become about 19.18 pounds, or 265 cubic feet, being 50 per cent excess,

and under those conditions, the furnace-boiler combination might be expected to discharge 542 cubic feet of gaseous products of combustion, at a temperature of about 500 degrees. The cold-air supply would have been heated at a cost of about 2,200 heat units, or about 17 per cent of the fuel heat.



THE GREEN FUEL ECONOMIZER, OR PRELIMINARY HEATER, AS ARRANGED IN THE BOILER FLUE.

If an air heater were installed in the "waste" gases, raising the air temperature 200 degrees by heat abstracted from the gas on its way to the chimney, the result would beneficially affect the furnace temperature, as the raising of the air from 260 to 500 degrees would require on the part of the fuel only 1,200 heat units. The gases however would have lost this heat, reducing their volume and lowering their temperature to about 380 degrees, and reducing the chimney draft in a 100-foot stack by nearly 2/10 of an inch of water. By reducing the size and increasing the height of the stack, the draft could be restored and the efficiency of the furnace increased by approximately 8 per cent, thus adding to the capacity of the combination. The evaporative effect of the boiler would be advanced, as the mean temperature of the fire would be hotter, and we might expect an increase of its efficiency of probably 5 per cent, which would make a heat saving in fuel of 1,000 heat units and a gain in steam of 415 heat units, or a total of 1,415 heat units.

Now, if for the above an economizer be installed to absorb the same "waste" heat into the feed water, we should have available, per pound of fuel, 1,000 heat units as the equivalent work of heating 265 cubic feet of air from 60 degrees to 260 degrees. This heat is now to be applied to raising the temperature of the feed water corresponding to the one pound of fuel, which taken under conditions of 60 degrees entering temperature, steam at 100-pounds pressure, and boiler efficiency of 65 per cent, equals, say, 7 2/10 pounds of water per pound of fuel. The available heat would therefore, raise the temperature of 7 pounds of feed-water, $1{,}000 \div 7 = 143$ heat units, which would bring the feed to a temperature of 192 degrees, or the additional heat put into the boiler would be $1{,}153 - 1{,}020 = 133$ heat units per pound $\times$ 7.2 $= 957$ heat units.

The superior advantage would thus be in favor of the air-heating process, because of the beneficial effect upon the furnace and boiler economy, and any greater volume of excess air supplied to the fire than that of 50 per cent would show relatively greater effect in economy, by the pre-heating of the air supply, rather than by ad-heating the feed-water supply.

The effect of air heating is well described by Seaton, as follows:

"The various beneficial effects of the heated air are not to be measured only by the direct recovery of so much heat that otherwise would be lost, but also by their effect in increasing the average temperature of the furnace, which again not only adds to the evaporative efficiency of the boiler, but also allows of a more facile and rapid union of the oxygen of the air with the gaseous products and the carbon of the fuel, so that actually less weight of hot air than of cold is required to effect the combustion of an equal amount of fuel in a given time. This further raises the degree of evaporative economy and power of the furnace, making an economy and rate of combustion possible, which otherwise would be unattainable."

It will be evident, that if the element of chimney draft be eliminated, and a sufficient and proper air supply provided by a steam-driven fan, (the exhaust of which is condensed, but the exhaust and the heat therein mainly returned to the boiler), it would be possible for the economizer to effect much more work in feed heating, even in combination with the air heater, for it could reduce the temperature of the gases to the greatest practicable extent and transfer its heat to the feed water, so that both furnace and boiler would be relatively advantaged by the combination.

The conclusion is that waste furnace heat should be first economized by its return to the source of waste, rather than to continue the prime cause of the waste and effect by its means an economy in another appliance.

THE DEVELOPMENT OF THE SMALL STEAM TURBINE.

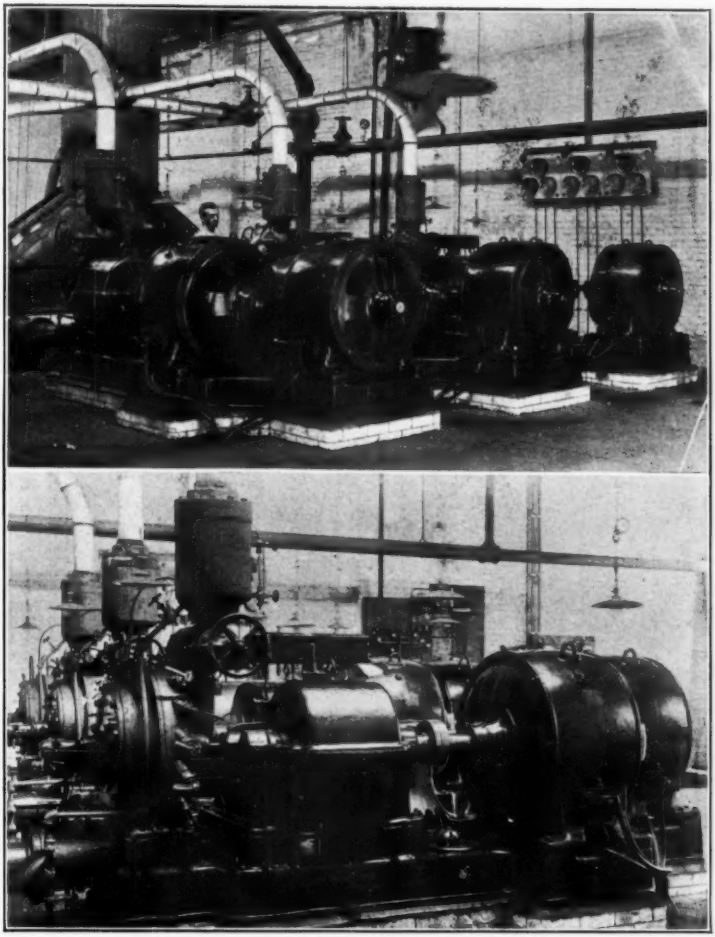
By Chas. A. Howard.

In the following pages Mr. Howard describes the prominent features of design and construction of the leading types of steam turbines of small capacity used in the United States. In an article to follow next month, he will discuss the various applications to which small steam-turbine units are adapted.—THE EDITORS.

AS a means of transformation of the heat energy of steam into useful work in the form of motion, the discovery of the steam turbine dates back centuries before any form of reciprocating engine was known. About 120 B. C., Hero, an Egyptian philosopher of Alexandria, discovered the basic principles of the reaction turbine. This was in the form of a hollow sphere containing water and mounted over a fire, the exit of the steam from the sphere being through a bent tube so that the reaction of the jet revolved the sphere in precisely the same manner as our modern reaction lawn sprinklers revolve. This was undoubtedly the first steam motor in the history of the world, so that it can be seen that the evolution of the heat engine began in its simplest form, the turbine.

In the year 1629, Giovanni Branca, an Italian, made the next important move in the development of the steam motor, by the invention of the impulse form of turbine, which, as produced by him at that time, consisted of a small tank of water placed over a fire with a nozzle projecting from the side of the tank. The jet of steam from this nozzle impinged on a wheel having a series of blades projecting from its periphery, thereby causing the wheel to revolve at very high speed. This, it will be seen, involves all of the fundamental principles of the De Laval turbine which was put into practical use for the first time in 1883. The multi-stage turbine (which is the only commercial machine on the market at the present time) is not so very new either, as in 1827 Real and Pinçon in France designed a thirty-one-stage impulse turbine which involved the basic principle of the modern Curtis turbine. The multi-stage reaction turbine was first brought forth by Tournaire in a paper presented to the French Academy in 1853.

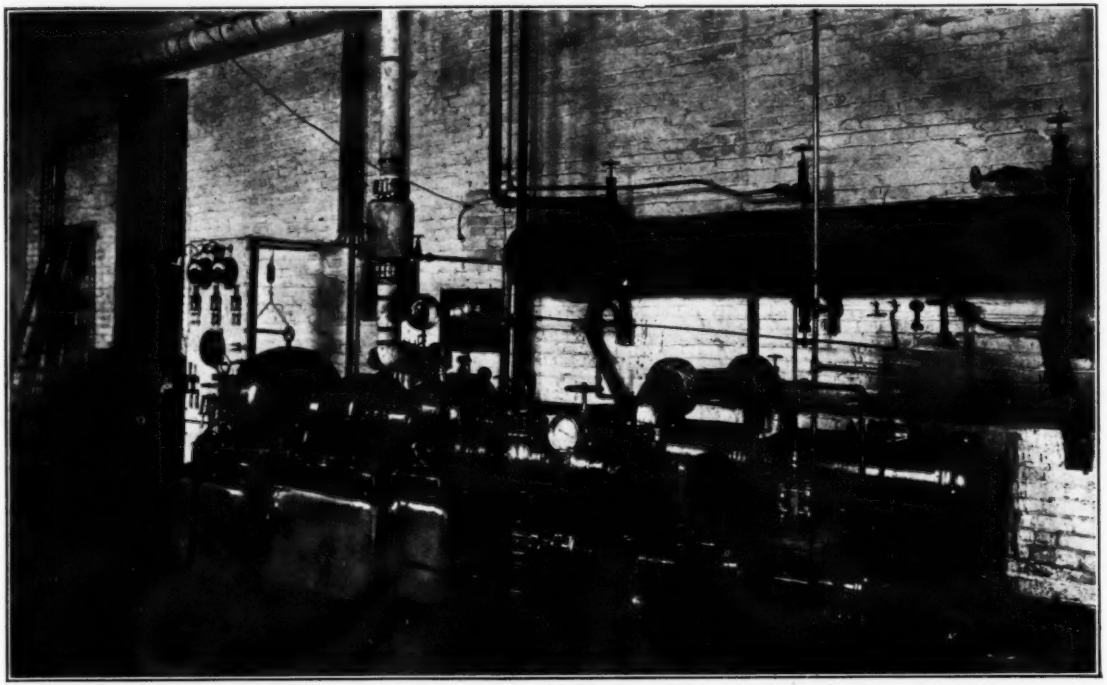
As a commercial machine, the turbine was first built by De Laval as a single-stage impulse wheel in 1883, and shortly after by Parsons



THREE 150 HORSE-POWER DE LAVAL TURBINES, POWER STATION OF THE AUTO-TRANSIT COMPANY, PHILA.

De Laval Steam Turbine Co., Trenton, N. J.

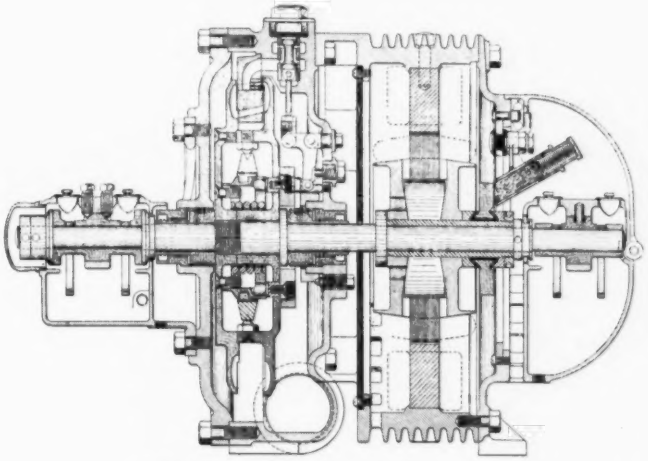
in the form of the multi-stage reaction turbine in 1884. From this time on, many new and improved machines have been developed by Curtis, Rateau, Riedler, Zoelly, and many others. Most of the designs of the small turbines on the market to-day and in the present process of development, that is of say 300 horse power and under, are an evo-



INSTALLATION OF 20-KILOWATT 125-VOLT DE LAVAL TURBINE GENERATOR, PLANT OF THE McJUNKIN-STRAIGHT DAIRY COMPANY, PITTSBURG, PA.

lution of the Riedler-Stumpf principle, which involves allowing the steam expanding from the nozzles to impinge directly upon the buckets on the turbine wheel; then after exit from the buckets, the steam is conducted through guide passages and strikes the same wheel again, this cycle being repeated a number of times.

The turbines most in use of this small size in the United States are the Kerr, the Terry, the Curtis, the Sturtevant, and still to some extent the De Laval. The Westinghouse is generally constructed only in larger sizes. For the usual speeds required for driving generators, centrifugal pumps, fans, blowers, etc., all the above machines with the exception of the De Laval are run direct-connected. Besides the ones noted above, there are several others of these small turbines which have been placed on the market very recently to a limited extent, and many more still in the process of development by many machinery manufacturers.



A SMALL DAKE-TURBINE GENERATING SET.

The first turbine commercially manufactured and sold in the small sizes in America was the De Laval. This is fundamentally the turbine of Branca, designed and constructed to suit the prevailing conditions as well as possible, and consists essentially of a series of nozzles from which the steam jets impinge upon blades fixed on the periphery of a wheel. The principle upon which this machine works is as follows: the steam entering the turbine through the throttle and governor valve under high pressure passes through a series of expanding noz-

zles where its energy in the form of pressure is transformed into velocity. The velocity of the steam on issuing from the nozzle is very high, as will be shown by the following calculation. With steam at 165-pounds absolute, expanding adiabatically through a nozzle to 18-pounds absolute, the velocity may be deduced as follows:

From the energy equation of a liquid and its vapor, the condition of an adiabatic flow is represented approximately by the equation:

$$(1) \qquad \frac{AV^2}{2g} = x_1 r_1 + q_1 - x_2 r_2 - q_2$$

where

A = the heat equivalent of work $\frac{1}{778}$
V = velocity of the jet in feet per second.
X_1 = moisture in steam at start.
X_2 = " " " " finish.
r_1 = heat of vaporization at start.
r_2 = " " " " finish.
q_1 = " " liquid " start.
q_2 = " " " " finish.
g = acceleration due to gravity, 32.2 feet per second.

In order to find the condition of the steam after exit from the nozzle, it must be remembered that in an adiabatic expansion the entropy remains constant. Hence if we solve the entropy equation, the value of X_2 may be obtained:

$$(2) \qquad \frac{x_1 r_1}{T_1} + y_1 = \frac{x_2 r_2}{T_2} + y_2$$

where y_1, and y_2 are the entropies of the liquid at the entrance and exit pressure respectively. Considering the steam dry at the initial pressure, we have

$$\frac{855.6}{826.5} + .5230 = \frac{958.5}{683.1} x_2 + .3282$$
$$1.037 + .5230 = 1.402\, x_2 + .3282$$
$$x_2 = .877$$

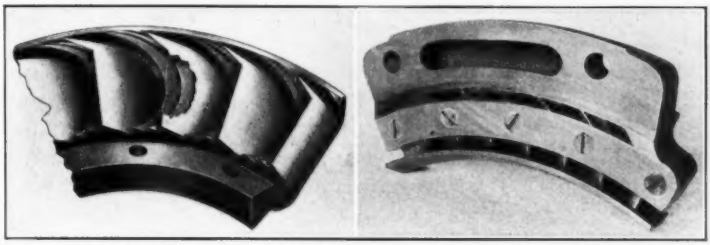
Substituting in equation (1) we have

$$\frac{V^2}{778 \times 64.4} = 1193.6 - .877 \times 958.5 - 191.3$$
$$V^2 = 778 \times 64.4 \times 161.3 = 8{,}082{,}000$$
$$V = 2840 \text{ feet per second}$$

The best efficiency of the De Laval wheel occurs when

$$V = \frac{C}{2 \cos a} \text{ where}$$

V = the linear velocity of the wheel,
C = the velocity of the steam,
and a = the angle between the nozzle and the plane of the wheel.



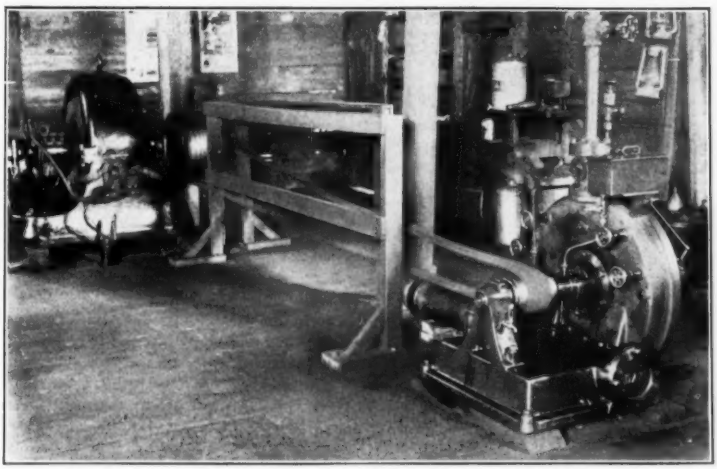
FEATURES OF CONSTRUCTION OF THE DAKE STEAM TURBINE.

On the left, segment of bucket ring, showing steps and end delivery of the buckets; on the right, nozzle and deflector vane block.

The angle a must be different for all speeds so that the steam may enter the blades without shock. This angle for the speeds at which this turbine ordinarily operates is from 17 to 20 degrees, so that the speed for the best economy under the steam conditions previously assumed, will be

$$v = \frac{2840}{2 \times .9397} = 1510$$

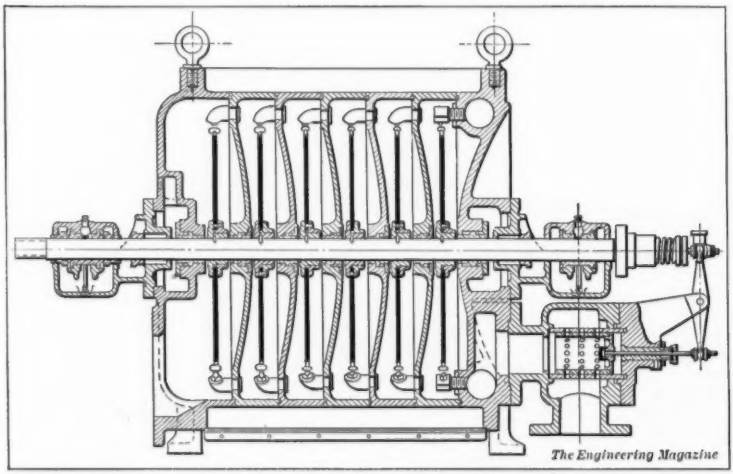
feet per second where the angle between the nozzle and the plane of the wheel is 20 degrees. This speed, which is over 17 miles per minute, is altogether out of practical reach, both for constructive reasons,



SINGLE-STAGE DAKE TURBINE BELTED TO 65-KILOWATT GENERATOR.

Taken when generator was running at 3,750 revolutions; coal consumption stated to be 1,800 lb. per 10 hours. Dake American Steam Turbine Co., Grand Rapids, Mich.

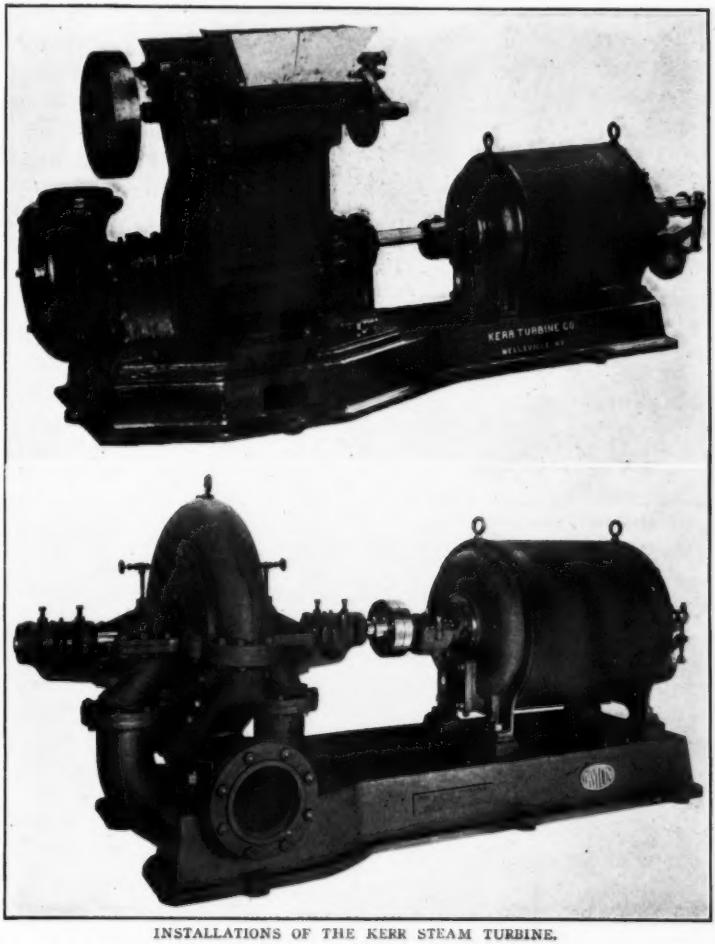
and on account of the inability to apply such tremendous speeds to any of our commercial machines without the use of gears; this, together with its excessive speed, is the undesirable feature of this turbine. In practical installations, however, the speeds are cut down considerably from these figures and of course the economy suffers accordingly, but the speed is never reduced to a point where the machine could run direct-connected in small sizes at say about 2,000 revolutions per minute, as the steam consumption under these conditions would be out of the question or else the diameter of the wheel would be prohibitive.



THE KERR STEAM TURBINE.

In order to get the speed of this turbine down to where it can be utilized for driving machinery, such as generators, blowers and centrifugal pumps, gears are resorted to, giving a reduction in speed of ten to one in most cases. The teeth of these gears are of the herring-bone type, set in two rows at 90 degrees to each other, partly to insure quietness of running and also to avoid the necessity of a thrust bearing. It might be imagined that these gears running at the terrific speeds which they do would make an unbearable noise, but though they could hardly be called quiet, the noise is very much less than would be supposed, as these gears are cut with the greatest care and accuracy on a special automatic machine used only for this work.

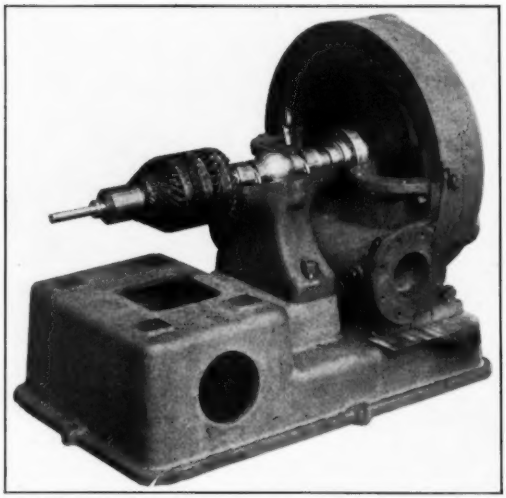
The balancing of the shaft and wheel of these turbines, some of which run at over 30,000 revolutions per minute, would be practically



INSTALLATIONS OF THE KERR STEAM TURBINE.

Above is a 25 horse-power turbine, 3,000 to 3,200 revolutions, coupled to Raymond pulverizer and air separator; below is a seven-stage 18-inch turbine coupled to turbine volute pump of double-suction high-speed Dayton type, capacity 1,200 gallons and speed 2,000 to 2,400 revolutions a minute. Kerr Turbine Co., Wellsville, N. Y.

impossible and is not attempted. The turbine wheel is mounted on a very small flexible steel shaft, supported by two bearings on the turbine proper which are so constructed that they will align themselves with the shaft. On the outboard end of this shaft, supported by two straight bearings, is the pinion which meshes with the gear or gears



STURTEVANT 3-KILOWATT TWO-BEARING GENERATING SET.
Cap of bearing and part of casing removed to show moving parts.

for the speed reduction. This flexible shaft, which is very slender, allows the turbine wheel, after it passes its critical speed, to revolve about its true center of gravity, instead of about its geometrical center as it does below this speed. The critical speed is a function of the flexibility of the shaft and occurs at a point considerably below the normal speed of the turbine wheel.

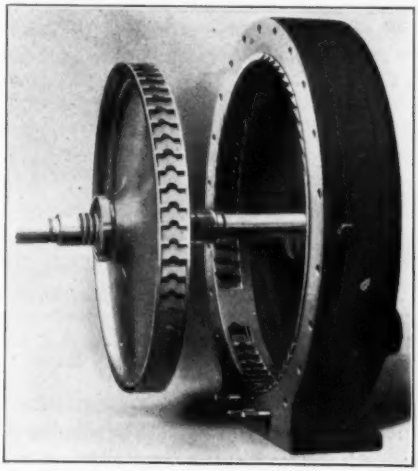
The turbine wheel itself, which is really the most important part of the machine, as far as strength is concerned, is made from a steel forging. In the smaller sizes, the shaft passes through a tapered bushing which is set in a hole drilled through the center of the wheel, but in the larger machines the wheels are made solid with the shaft in two pieces screwed into the flanges on the face of the wheel. The buckets, which are drop forgings, are made with a bulb shank fitted into slots milled parallel to the axis in the rim of the wheel. This method of construction makes it a comparatively easy matter to take out damaged buckets and insert new ones when occasion requires.

The speed regulation of this turbine is sufficient for all practical purposes and is accomplished by a governor valve which throttles the steam supply. This governor valve is a double-disc balanced valve and is actuated by a bell-crank lever from the governor shaft. The governor itself consists of two small weights which are pivoted on knife edges and held in position by a spiral spring. When the speed rises above the normal, these weights spread apart by the centrifugal force and push forward the governor pin which acts on the bell-crank lever, closing the governor valve. If the turbine runs condensing, when the load is very suddenly thrown off, so that merely closing the

governor valve will not take care of the speed fluctuation, a vacuum breaker is connected to the governor so that when the speed has increased above the normal to a pre-determined point, this valve will open to the atmosphere, breaking the vacuum.

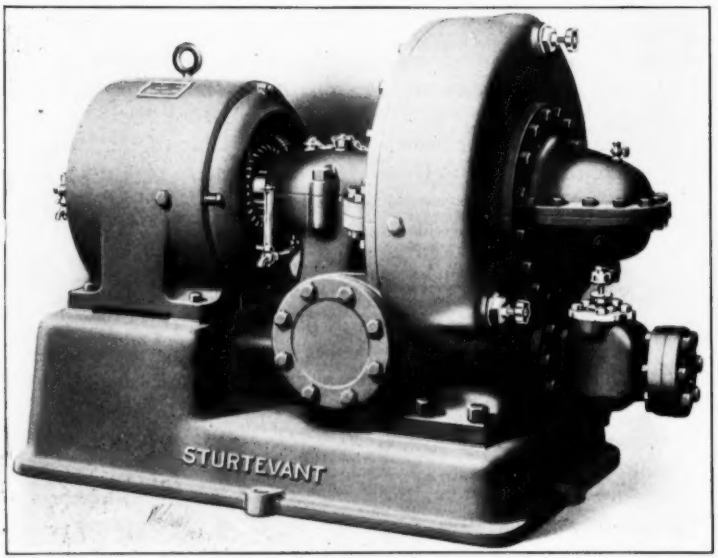
The Kerr turbine, which is being installed in large numbers for various kinds of service, is practically (if it may be called so) a multi-stage De Laval. It is purely of the impulse type and does not utilize the reaction of the steam in any way whatever. Perhaps the simplest description which can be given of it is to say that it consists of a series of Pelton water-wheels on the same shaft, so placed that the steam issues from the nozzles of the first stage and impinges upon the buckets of the wheel where it gets a complete reversal, and then passes through the second nozzle onto the buckets of the wheel in the second stage, and so on through the machine. By this means of dividing the turbine up into several stages, the drop in pressure per stage, and hence the velocity energy to be taken out of the steam at each stage, is very much less than when only one stage is used, so that the speed of rotation can be made very much lower for the same economy than is possible with single-stage machines of the same diameter.

The nozzles of this turbine, in contrast to those of the De Laval turbine, are convergent, as these have been found to give the greater efficiency; this is partially on account of the type of bucket used; but mainly because a high velocity of the steam jet is neither necessary or desirable. Since several stages are used, the velocity of the steam jet on leaving any of the nozzles can be kept in the neighborhood of 400 to 500 feet per second, while in the single-stage or De Laval turbine, the velocity of the steam jet is around 2,500 to 3,000 feet per second. The linear velocity of the buckets in this turbine should be approximately one-half the velocity of the steam jet for the best economy, which is approximately 200 feet



BUCKET WHEEL, REVERSE GUIDE RING AND CASING, STURTEVANT STEAM TURBINE.

per second. For a 24-inch-diameter wheel, this would correspond to 1,900 revolutions per minute as the speed for the lowest steam consumption. It can be seen of course that this figure varies with the initial steam pressure and temperature as well as with the back pressure, and it should also be noted that the speed given is for the lowest possible steam consumption. When the speed is lowered, the horse power falls off proportionately; and since the amount of steam which passes through the turbine depends only on the pressure outside of the first nozzles and the back pressure, when the load is sufficient to keep the governor valve wide open, the amount of steam which flows through the turbine is constant as long as the initial steam and final exhaust pressures remain the same, irrespective of the speed at which the machine is running. This means that the steam consumption increases in inverse proportion to the speed at which the turbine is run.

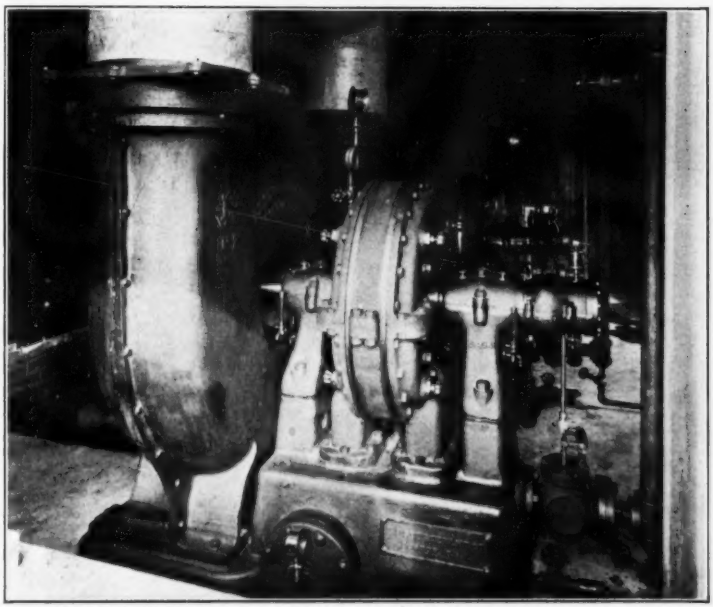


STURTEVANT TWO-BEARING GENERATING SET.

Made in sizes from 3 to 75 kilowatts, especially for marine work and for service where space is limited.

The Kerr turbine rotor consists of a series of wheels on the shaft, one wheel for each stage. The number of wheels which are necessary depends on the steam and exhaust pressure, the diameter of the wheels, and the number of revolutions per minute, at which the turbine

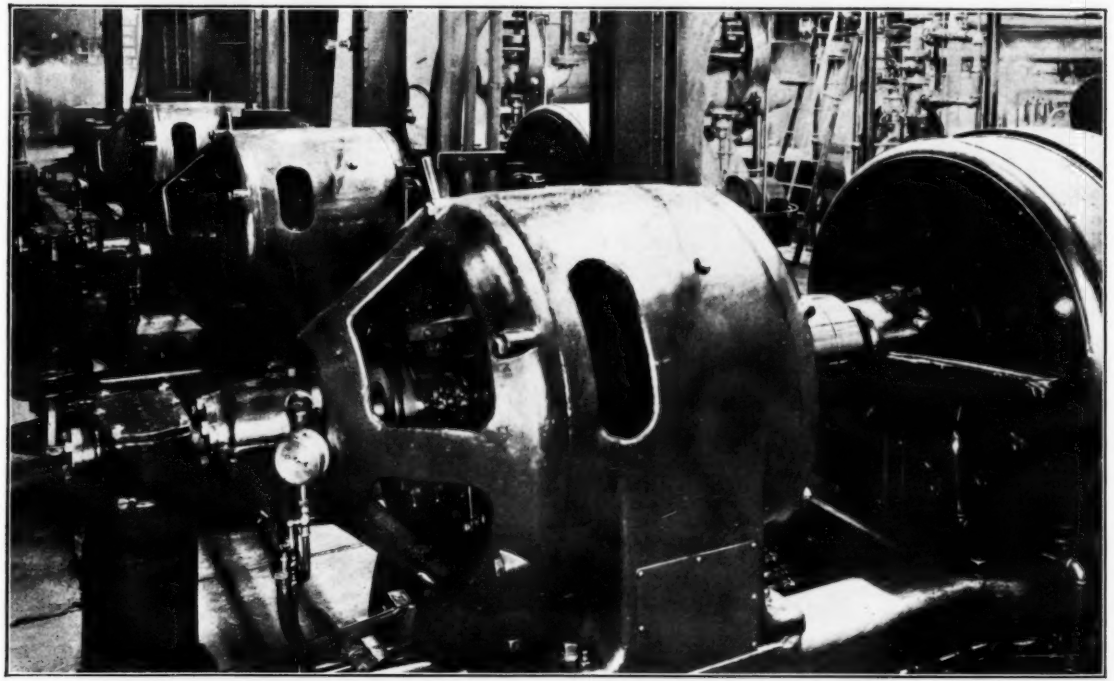
is to run. These wheels or discs carrying the buckets are made from sheet steel and slotted around their circumference to receive the drop-forged steel buckets, which are each provided with a bulbed shank that slides into these slots on the discs and is then riveted over on both ends. The buckets are of the well-known Pelton type and are designed to give a complete reversal of the steam. The bucket wheels are each mounted upon a split hub and held in place by a cast-iron ring threaded into this hub, the hub itself being keyed to the shaft.



STURTEVANT TURBINE GAS BLOWERS, NORFOLK GAS COMPANY, NORFOLK, VA.

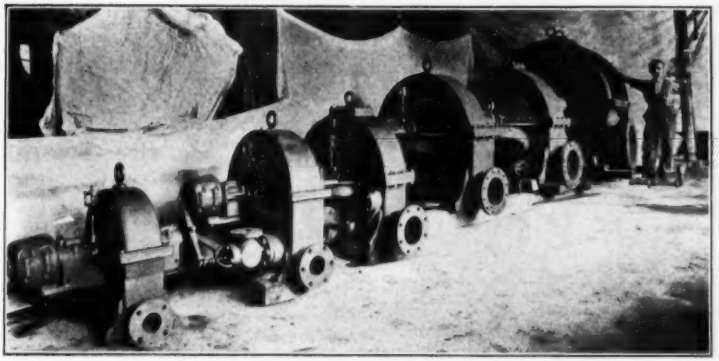
The governor is very similar to the one used on the De Laval turbine, but the governor valve and the system of levers which operate it are considerably different. The governor is located on the main shaft and acts directly on the governor valve through the medium of a rocker arm only. The valve is of the sliding-piston type, throttling the steam as the load demands. The centrifugal force of the governor weights is balanced by a spiral spring, and by varying the tension of this spring, the speed may be adjusted as desired.

Outside of the Kerr turbine and the De Laval, most of the other small turbines are developments of the Riedler-Stumpf turbine. This



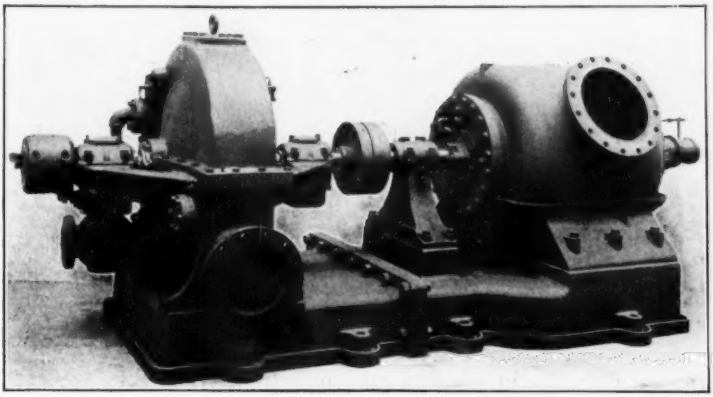
CURTIS STEAM TURBINES, INSTALLED FOR THE WEST JERSEY & SEASHORE R. R., WESTVILLE, N. J.

The turbines are coupled to 75-kilowatt 125-volt generators at 2,400 revolutions. The General Electric Co., Schenectady, N. Y.



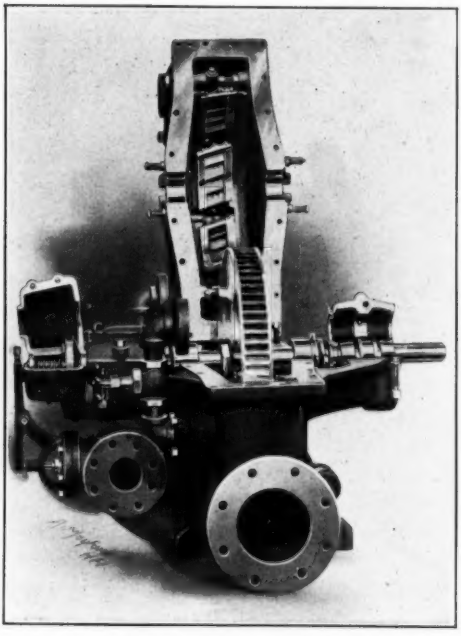
A ROW OF TERRY STEAM TURBINES, FROM 10 TO 600 HORSE POWER.

is a low-speed impulse machine, and in the fundamental principles of its operation does not differ to any great extent from the Kerr turbine. In the Kerr turbine, the steam is passed through a series of nozzles and a part of its energy of pressure is converted into velocity, leaving at the exit side of the nozzles in the first stage still considerable pressure, while the velocity of the jet is imparted to the wheel. From this pressure, the steam passes through another nozzle into the second stage and so on through all stages, so that the pressure is reduced from the initial pressure to the exhaust by as many successive steps as there are stages, and at each one of these steps the energy due



TERRY TURBINE-GENERATOR PUMPING UNIT.

Consists of a 150 horse-power turbine direct-connected to centrifugal pump; at 1,600 revolutions has a capacity of 9,500 gallons per minute against a lift of 40 feet.

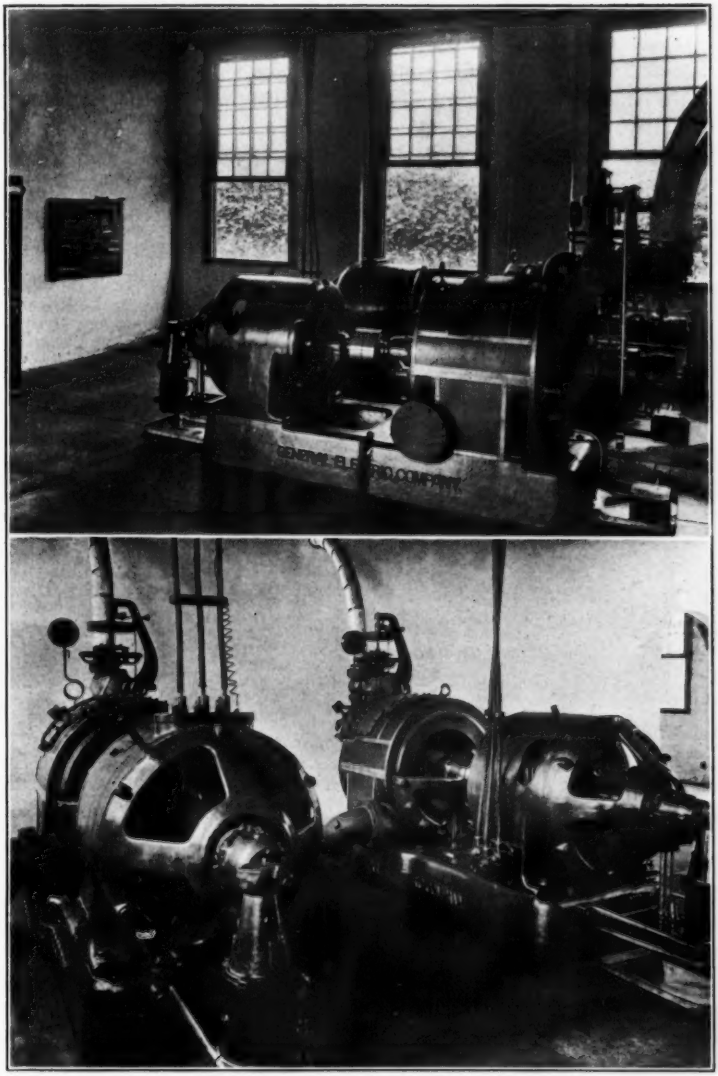


THE TERRY STEAM TURBINE WITH CASING OPENED.

The unit photographed is of 100 horse power. Terry Steam Turbine Co., Hartford, Conn.

to the loss in pressure is imparted as velocity to the wheel. The Riedler-Stumpf, on the other hand, passes the steam through only one series of nozzles, whence it impinges upon the buckets of the rotor, which are very similar to single Pelton buckets; and after exit from the buckets, it passes through guide passages and then strikes the same wheel again, and so on for several times. In practice, some of the machines are so designed that the whole pressure energy of the steam is converted into velocity in the nozzles, so that the pressure does not change in the guide passages, and others are so proportioned that the pressure falls in the guide passages so that they serve the purpose of nozzles. When built in this manner, the only difference of any account from the Kerr turbine is that the steam is used over and over on the same wheel in the Riedler-Stumpf, while the Kerr uses a separate wheel for each stage.

The most used machines of this type at the present time in this country are the Sturtevant and the Terry turbines. The Sturtevant turbine has one feature about it that is different from any other turbine, and if not of any great value is certainly unique. This is in the construction of the rotor, which is made out of one solid steel forging, with the buckets milled out of the solid metal. While this construction is no doubt stronger than that in which the blades are inserted, it is doubtful if the gain is worth the extra cost of this type of wheel. Among the small turbines, which we are considering, none has had the least trouble from buckets working loose or coming off.

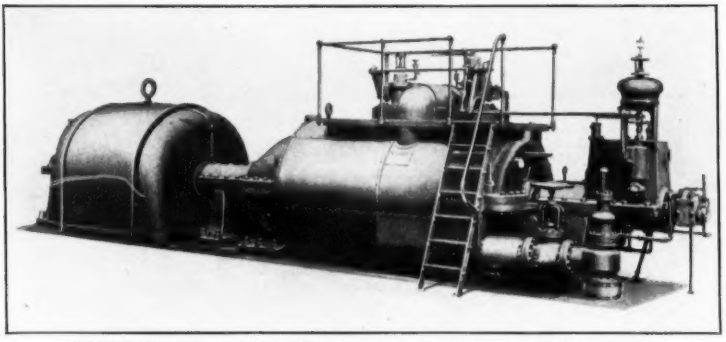


INSTALLATIONS OF CURTIS STEAM TURBINES IN SERVICE.

Both views are taken in the plant of the Ferracute Machine Co., Bridgeton, N. J. The turbo-generators are of 75 kilowatts, 2,400 revolutions, 250 volts.

The buckets in the Sturtevant turbine are generally milled on the two sides of the wheel with reversing guide passages on each side of it. The action of the steam is precisely the same as previously explained in the general Riedler-Stumpf type of turbine, of which this is a representative. The speed of this machine is governed by a centrifugal governor composed of three revolving weights, whose centrifugal force is opposed by a spiral spring which can be adjusted to regulate the speed at any fixed rate. The governor valve is a throttle valve actuated from the governor spindle by a rod and lever.

The Terry turbine on the whole is very similar to the Sturtevant and differs only in the details of its construction. The buckets are inserted on the wheel and held in place by keys riveted over at each end, so that they are practically as rigid and solid as if all in one piece. These buckets are placed on the face of the wheel instead of on the side, as in most of the Sturtevant turbines.



WESTINGHOUSE-PARSONS 300-KILOWATT TURBINE-GENERATOR UNIT.

There are several other turbines which have just entered or are about to enter the market. Most if not all of these machines are designed on the Riedler-Stumpf idea, like the Terry and the Sturtevant, and differ from each other principally in the details of construction. The Curtis turbine is used to some extent in the small sizes and differs from the larger machines of this type in the fact that it is horizontal, which necessitates constructive changes in the details, but on the whole it is very similar to the large vertical Curtis turbine which has been described so often and is so well-known that a description of the smaller unit is unnecessary. The Westinghouse turbine, which upon its advent in the American market some years ago gave a strong impetus to the development and use of this type of motor in place of reciprocating engines, as already stated, is built almost exclusively in units of larger size than are contemplated in this article.

THE USE AND CONSERVATION OF WATER POWER RESOURCES.

By H. Von Schon.

III. TYPICAL CASES AND DEFINITE PROGRAMMES FOR THEIR TREATMENT.

In two preceding articles on this subject the needs and effects of the conservation of the rivers' flood run-off were clearly set forth, not only as regards the influence upon the water-power resources, but also in relation to re-forestation, flood prevention and inland navigation; it was stated that the present available water power may be more than tripled by a storage programme the cost of which could readily be borne by this enhanced water-power asset while all the other benefits would come as collaterals without charge. Furthermore the author asserted that the conservation of water powers would be accompanied by the rapid development of the now unutilized opportunities to their fullest economical output capacity, and that all generated current would find ready employment, that every community might enjoy the advantages accruing from economical electric energy, that transportation by rail and inland navigation would be moved largely by electric energy, and that thus the problems of the future industrial development would find more radical solution than any other practical scheme can promise.

In this, the closing article of the series, endeavor will be made to substantiate these various propositions by analyzing some typical cases of rivers as to their present water power status and the development of the obtainable conditions and their influences, by a discussion of practical conservation programmes.

THE illustrations of typical, concrete conservation problems which I shall present in this article are chosen for the purpose of covering the extremes of hydraulic and industrial conditions; they would be classified as private, State and Federal conservation programmes, dealing with rivers in northern and southern States; the localities include those whose rail-transportation facilities are of the best, and those which have none—sections from which staples are drawn, and others where they are manufactured; finally, they cover river systems which may be best conserved by corporations in co-operation with the State, or by the State or the United States. All these include re-forestation, inland navigation and flood prevention, and the important collaterals of soil protection and water clarification. The facts as quoted in connection with these are taken from State and Federal records, as well as from data collected by me in the course of personal examination of power sites on the rivers presented.

Before entering upon the analysis of these typical rivers it may be pointed out that the major benefit of flood control will be experienced by water-power opportunities of low or medium head; the high-fall

powers, not already developed, are, with few exceptions, found near the headwaters of streams where the contributing catchment area is not extensive and the benefits from flood control are correspondingly limited. Normal river slopes are one foot per mile and greater, and water powers may therefore be developed at intervals of fifteen to twenty miles—not, however, under the present conditions of uncontrolled flow, as these developments would be prohibitive in cost if not impracticable—but realizable with a conservation programme in existence. This will be clearly demonstrated in the case of one of the rivers to be discussed. In Europe many important water-power developments have been and are now being carried out with heads of six and four feet and at least one, on the Rhine, with a still lower fall.

It is furthermore interesting to note that a recent advance in transmission voltage, by the placing in service of a 110,000-volt line in Michigan, is a clear indication of the rapid elimination of distance as an obstacle to electric-current service. The Bay County line in California transmits current 208 miles with a voltage of 80,000; the Muskegon line above referred to employs a voltage 35 per cent greater which, correspondingly applied to distance, would make the coast line 280 miles long; and there is no doubt in my mind that the day is not distant when 200,000-volts and 500-miles transmission will be entirely practicable. That long-distance transmission however is available only for correspondingly large outputs goes without saying; but it is quite feasible to put the current outputs of a number of successive plants along the same river on one trunk transmission line so that the power developed from a considerable reach of a river may be transmitted over long distances. With the present price of copper, lines can be put up for $1,500 to $2,000 per mile, and with proper balancing of voltage and current the transmission investment need not exceed $25 per kilowatt delivered, making the annual charge due to transmission including interest, maintenance, depreciation and operation, about $5 per kilowatt, or less than two-tenths of a cent per kilowatt hour on 3,000-hour service.

The first river to be analyzed is in a northern State where flow fluctuations are of the smallest, speaking relatively of the rivers of the United States—a river which is entirely within the borders of one State, on which considerable power is developed; in fact, it would probably be correctly classed as one of the best developed power streams in the country. No navigation exists at present. This river belongs to that large class embracing the important tributaries of the Missouri and the upper Mississippi, of the Great Lakes drainage

areas, and of many of the rivers of the New England States and of the North Atlantic Coast. This is a class of rivers which it might be thought could not be very greatly benefited by conservation of flow, since the flood run-off is not excessive, most of these rivers having their source in lakes and extensive swamps while their headwaters remain, in part, well forested. These rivers have served the lumbermen and the grist-mill operator in the past and they are now available for hydro-electric developments. The Wisconsin River belongs preeminently to this large class; its catchment area of 12,280 square miles lies in the State which is named after it. The total descent of the Wisconsin aggregates 1,046 feet in a length of 428 miles; its run-off is from 0.8 to 3.0 cubic second feet per square mile of drainage area. January, February and December are the low, April, May and June the high-flow months. Power development for continuous output may be based on an available flow of one cubic second foot per square mile of contributory catchment area.

The practical power sites, the fall which can be utilized at each, and the continuous power output in electrical horse power, based upon the aforesaid available flow, are given in Table 1, which is compiled from a recent report of the Wisconsin Geological and Natural History Survey, Mr. A. E. Bridge, Director.

TABLE 1. POWER DEVELOPMENT DATA OF THE WISCONSIN RIVER.

Site.	Fall.	Drainage area.	Horse power.	Developed.
Prairie du Sac	20	9,500	15,000	none
Kilbourn	17	8,400	11,500	8,000
Needah	10	7,000	5,600	none
Old Barnum	10	6,000	4,800	none
Neekoosa	75	5,800	34,000	12,000
Grand Rapids	25	5,700	11,500	7,500
Biron	12	5,650	5,200	3,000
Stevens Point	40	5,600	18,000	6,500
Battle Island	14	4,800	5,000	none
Mosinee	20	4,400	7,000	50
Rothchild	18	4,200	6,000	none
Wausau	25	3,500	7,000	1,800
Brokaw	45	3,300	11,500	4,000
Trapp Rapids	20	3,000	4,800	none
Merrill	20	2,900	4,500	3,200
Bill Cross Rapids	20	2,600	4,000	none
Grandfather Rapids	85	2,500	17,000	4,000
Grandmother Rapids	17	2,300	3,200	none
Tomahawk	15	2,100	2,500	2,000
Pine Creek Rapids	20	1,800	2,800	none
Whirlpool Rapids	28	1,300	2,900	none
Hat Rapids	20	1,200	2,000	1,400
Rhinelander	70	940	5,200	3,000
Rainbow Rapids	10	700	600	none
Otter Rapids	16	500	640	none
Total	672	.....	192,240	56,450

The river's power capacity with unconserved flood run-off appears from this as 190,000 horse power, and there is considerable more on the tributaries. An exhaustive investigation of the reservoir possibilities on this river in connection with a programme relating to navigation on the Mississippi, was made by the United States Engineer Corps some years ago. Eight reservoir sites were located with an aggregate storage capacity of 20,000,000,000 cubic feet; these reservoirs have a contributory drainage area of 1,410 square miles, would fill (with a run-off of 1.25 cubic second feet) in about four months (March to June) and could furnish a continuous flow of 2,500 cubic second feet during the three low-flow months, December to February; by this the present power capacity of 190,000 horse power would be increased to 315,000 horse power. This increase of 125,000 horse power, with a charge of $10 per horse power, or $1,250,000 total, would pay the interest, at 5 per cent, on an investment for storage reservoirs of $25,000,000. A higher charge could be paid by it, since the increase of cost to realize this additional output would be only that due to the additional generating equipment and perhaps a larger power station. The cost of the dam would be the same as for the smaller flow, while that of works now required to control the flood volume, such as waste ways, gates, etc., would be reduced. The conservation programme would practically eliminate all floods on the river, and the complete development of the enumerated powers would make the Wisconsin a navigable river, which it is not at present.

The market for all the electric power which can be developed, the 315,000 horse power, is in the river valley at Prairie du Chien, Prairie du Sac, Sauk City, Madison, Baraboo, Portage Mauston, New Lisbon, Needa, Grand Rapids, Stevens Point, Mosinee, Wausau, Merrill, Tomahawk and Rhinelander; for the operating of the Wisconsin Central, the Chicago, Milwaukee & St. Paul, and the Chicago & Western Railroads on their lines paralleling the river; and for barge haulage on the river, as the bulk of the manufactured products could be thus transported down the Wisconsin into the Mississippi.

The Wisconsin is the first of the important American power rivers on which proper steps have been taken to bring about the control of the flow by a flood run-off conservation programme. The Federal Government investigated this subject, as has been stated, years ago—not, however, for the purpose of conserving the water-power resources nor for the creating of navigation on the Wisconsin, but as one of the factors in connection with navigation on the Mississippi.

This investigation was extended to several of the important Mississippi tributaries and a number of reservoirs were constructed on the upper Mississippi and have been in operation for a number of years. The State of Wisconsin is prevented constitutionally from entering upon any such undertaking as the creating of storage reservoirs, but the owners of some of the most important power sites recognized the value of conservation years ago, and pooled their interests in this direction for the purpose of securing legislative authorization to acquire storage sites, construct and operate reservoirs, and collect toll from the beneficiaries of such a programme; and after several fruitless attempts, they finally succeeded last year in securing the passage of a statute incorporating the Wisconsin Valley Improvement Company, with authority to exercise the power of eminent domain for the acquiring of necessary lands, and to collect tolls from water powers. The company is to operate under the supervision of a State Commission, and the State reserves the right to take over the company's works at a stated valuation whenever constitutionally authorized to do so. The capital stock of the company was allotted to the owners of water powers in ratio of the power capacities controlled by them, 790 shares out of the total 1,000 being thus distributed between twenty-five power owners. This is the programme generally outlined in my former articles, with the, to me, recommendable addition of a tax upon all the powers, whether developed or not, thereby securing the prompt development of all, preventing the withdrawal of this valuable public power resource from the market, and thus making the cost to the consumer the lowest practicable; and finally the river is rendered navigable without any serious additional expenditures on the part of the Federal Government. This example of a practically accomplished conservation undertaking will serve as a model applying to a large number of other rivers in the United States where it is equally practicable and would be effective. The people of any State in the Union would readily recognize the immense benefits to be derived by them from such a programme and their legislatures would or should be ready to emulate the statesmen of Wisconsin. Furthermore, this programme possesses the elements of an attractive financial investment and, where justifiable by probable results, none should have to seek long for the needed support. To enumerate the rivers which are capable of a conservation treatment like that planned for the Wisconsin would make a long list; some represent returns not quite as promising, others better.

The second typical case to be presented is of one of the southern rivers of that large class which has been made navigable by the Federal Government by the construction of successive dams and locks, but on which little water power is now developed because the available sites are under Government control, while the flow fluctuations are of such extremes that, even with a liberal policy on the part of the War Department in granting permits and leases for power development, these do not now represent attractive ventures. Navigation itself is uncertain, as in low-flow seasons the proposed channel depth cannot be maintained, while the annual flood damages run into many millions. The floods of last August are still fresh in the memory of the readers.

The Kentucky River's catchment area of 6,900 square miles lies entirely in the State of Kentucky; the river's fall is some 1,089 feet, its length 380 miles. The run-off is well-known from gauge readings at Government dams for a long period of years; it ranges from 0.05 for the minimum to 3 second feet and higher for the flood flow. The monthly mean run-off during the year 1905, as measured by me at the Government dam at Valley View, near the center of the catchment area, was as per Table 2:

January	0.20	cubic	feet	per	second	per	square	mile.
February	0.25	"	"	"	"	"	"	"
March	1.70	"	"	"	"	"	"	"
April	1.30	"	"	"	"	"	"	"
May	1.00	"	"	"	"	"	"	"
June	0.50	"	"	"	"	"	"	"
July	0.25	"	"	"	"	"	"	"
August	0.20	"	"	"	"	"	"	"
September	0.15	"	"	"	"	"	"	"
October	0.15	"	"	"	"	"	"	"
November	0.25	"	"	"	"	"	"	"
December	0.60	"	"	"	"	"	"	"

This was a normal precipitation year.

The Government is carrying out a programme to create slack-water navigation as far up the river as the Three Forks, which is a distance of 260 miles; this requires fifteen locks and dams; twelve are now in commission, and the others will be in a couple of years. The location of each of these dams, the area of the contributing drainage, and the power capacity in electric horse power represented at each of these, based upon a continuously available flow of 0.2 of a second foot, are given in Table 3.

There is some 800 feet more fall on the branches above the head of navigation. The only water power now developed is of some 70 horse power at Frankfort.

Location.	Fall, in feet.	Drainage area. Sq. miles.	Power capacity. Electrical horse power.
1, Carrollton	16	6,840	1,760
2, Lockport	14	6,075	1,360
3, Gest	13	5,960	1,240
4, Frankfort	14	5,350	1,200
5, Tyrone	14	5,230	1,160
6, Warwick	14	5,170	1,150
7, High Bridge	15.5	5,100	1,340
8, Little Hickman	18	4,620	1,320
9, Valley View	18	4,210	1,200
10, Ford	17	4,110	1,180
11, College Hill	18	3,330	960
12, Wagersville	18	2,880	820
13,	18	2,620	760
14,	18	2,500	720
Totals	225.5	.....	16,170

I have made designs for developments at several of the sites and, generally speaking, have found the opportunities good for low development cost; but the annual flood stages, sometimes three per year, go to such extreme heights that then no working head remains, and these periods frequently are of ten days and longer. A considerable portion of this flood run-off could be economically stored; in fact, it appears likely that reservoir sites are available in which the flood flow of the headwaters catchment basin of some 2,000 square miles could thus be stored to the extent of 16,000,000,000 cubic feet and more. These reservoir sites are in the lower valleys of the chief tributaries or forks; the slope of these is quite flat toward their outflow into the main river and the lower ends of the valleys contracted, affording short dam sites on rock ledges. These reservoir sites may aggregate a storage area of some 15 square miles, with a mean storage depth of 40 feet; the storage volume could be accumulated from a run-off of one second foot during a period aggregating three months and, if distributed during the six low-flow months, the natural flow could be enhanced by about 1,000 second feet, and this increase for the fall at the fourteen dams would represent a power, in addition to that quoted, of 18,000 horse, or practically a total power capacity for the river of 35,000 horse power. The flood rises would be so diminshed that a working head would be available at all times. The navigation programme which is now being completed by the Government aims to secure a channel depth of 5.5 feet, but this is not realized during the very low months when the depth is frequently reduced, over certain reaches, to 2.5 feet; its maintenance requirs a constant and considerable expenditure for the dredging of bars and shoals deposited by the floods. The navigation works have cost $3,000,000, and will require

to complete them, $1,700,000. Operating and maintenance of works aggregates to date $1,250,000, or practically a total of $6,000,000. The annual cost of dredging is about $30,000.

This important investment has not as yet had any appreciable effect on freight rates, and therefore on the encouragement of water transportation, the annual tonnage being now less than 300,000. The adding from storage of a flow of 1,000 second feet during the low stage months would create all-year navigation for 1,000-ton barges, and then the Kentucky would become one of the busiest inland waterways in the South.

And what of the cost of securing this certainly much to be desired condition, making 35,000 horse power of electric energy available to supply one of the best current markets in the South—to render this river navigable, in fact? The land for the reservoirs, some 10,000 acres, might cost $100,000, the dam need not exceed 100 feet in height, and, while my data are not conclusive, I believe they can be constructed for $4,000,000 or less; maintenance and operation might run to $25,000 anually; 5 per cent. interest on the investment of $4,100,000 would be $205,000; operation and maintenance, $25,000. This makes the annual charges against the reservoir system $230,000. If taxed entirely to the water-power resources of some 35,000 horse power, it would amount to $6.60 per horse power.

Is there any question that this is a good investment for the Government to create this storage system and lease the power privileges? Or for a private corporation to secure the necessary authority from the State and from the United States, similar to that vested in the Wisconsin River Valley Improvement Company? Can the power be sold remuneratively? Frankfort, Lexington, Richmond, Paris, Winchester, Versailles, Shelbyville, Carrollton, Nicholasville, and other smaller towns in the rich "Blue Grass" region; the coal mines, barge haulage, and the fast growing electric-railroad net in that section—these will consume more than the output quoted, and if there is any left, the focus of this power field is only 135 miles from Louisville and 150 miles from Cincinnati, and there is some 30,000 horse power available from another stream not so distant from the Kentucky but that it can be taken into a trunk transmission line for these large centers.

Will it pay the Government to stop the annual dredging expense, to collect a handsome revenue from the power privileges, to operate the locks electrically instead of erecting and operating steam plants for this purpose as is now being done at several of the Government

lock sites? Will it pay to diminish, if not eliminate, the constantly recurring floods and the dangers to the Government navigation works, which are constantly threatened by them? Two years ago one of these floods on the Kentucky River washed out the abutments on two of the new dams which had just been accepted by the Government from the contractors, and the required repairs amounted to a considerable sum. But the case, it seems to me, has been sufficiently made out. There are quite a number of rivers in this class; Table 4 gives a partial list of Government Locks and Dams with respective falls:

River.	State.	Number of Government Dams.	Aggregate Fall.
Allegheny	Penn.	3	30 feet
Barren	Ky.	1	15 "
Big Sandy	Ky.	3	46 "
Black Warrior	Ala.	11	112 "
Columbia	Ore.	1	20 "
Coosa	La.	5	46 "
Cumberland	Tenn.	8	90 "
Illinois and Mississippi	Ill.	29	274 "
Kanawha	W. Va.	11	100 "
Muskingum	Ohio	10	115 "
Ohio	Pa., Va. and Ky.	10	80 "
Ouachita	La. and Ark.	2	26 "
Rough	Ky.	1	9 "
Tennessee	Tenn.	12	136 "
Upper White	Ark.	2	28 "
Wabash	Ill.	1	11.5 "
Total		110	1,138 feet

It is not claimed that the programme suggested as feasible in connection with the Kentucky River applies to all of these, nor is it positively known that it would not. Here are 110 dams built and maintained by the nation, representing a large amount of available water power; it is submitted that the possibilities of rendering that power available for industrial purposes should be fully exploited by the National Government, because it is in control and most vitally interested. If these investigations show the feasibility, then capital will not be lacking to improve the opportunities.

In conclusion of this series the author submits the following general outline of a programme which it appears may realize conservation of our now wasting water-power resources:

First. Examinations of storage possibilities; these should be made by the Federal Government or States, as the river is interstate, navigable, or not. Such examinations would be carried on by preliminary methods, reconnaissance, flying levels, and stadia compass surveys; these can be executed economically; level lines at $4.00,

topography $5.00, and mapping $1.00 per mile, is the cost record of a recently carried out State survey for the same purpose in Wisconsin. Where the river is entirely in the one State and not navigable these examinations are logically a State project; when the river passes through several States they should act jointly or co-operate with the Federal departments. Navigable rivers are pre-eminently National subjects of this kind. Much of the required information has already been secured in connection with the surveys for the original navigation programme; the available power sites are occupied by the locks and dams and therefore have been surveyed in detail—in fact, this is chiefly a work of compilation, this exploitation of the feasibility of power conservation on rivers occupied by Government locks and dams, probably supplemented by some reconnaissance work to locate the reservoir sites. The Government has all the necessary force and equipment to carry on this work, in several different survey departments, and some of both could no doubt be utilized for this purpose without seriously impeding or interfering with the current duties of these organizations.

Second. Publication of the collected storage and power data by the States and the United States, for the purpose of bringing them to the attention of private enterprise and capital, having the storage works constructed and the powers developed in accordance with the most efficient methods and with plans approved and under the supervision of the State or the United States.

Third. Chartering organizations by State and Federal legislation to create reservoir systems, vesting in them the power of eminent domain for reservoir and flowage areas, and giving them authority to collect toll from all available water powers of a minimum head.

Fourth. Chartering corporations by State legislation to develop the water powers and market the current, vesting in these the power of eminent domain to cover development sites, pondage areas, and transmission-line right of way, and regulating and supervising the development programme and methods and the current prices.

Fifth. Completing the navigability on the river, the National Government appropriating the funds required for the construction of the locks, the dams being erected by the development concerns, regulating the use of the water and the price of the current to be supplied to the Government for the operation of locks, and for electric barge haulage; navigation of the river to be toll free.

Is all or any of this practical? This will only be determined by writing and talking and thinking about it a good deal.

WAYS AND MEANS OF PRODUCING WORK IN THE MACHINE SHOP.

By W. Burns.

Mr. Burns, while voluntarily assuming the position of an outsider looking through the machine shop, yet directs a line of inquiry which might advantageously be followed by a careful owner or manager seeking the improvement of his own plant. The less familiar line of approach—interrogatory rather than didactic—may make this analysis of shop conditions contributing to efficiency more than ordinarily suggestive.—THE EDITORS.

WHEN we go into a strange shop or one engaged on a different class of work from that with which we are familiar, we insensibly make comparison between the shops we have hitherto known, and the one under observation. If it is a large shop and crowded with machines and plant it may take us some little time to itemize the whole equipment, and so get a basis for comparison. But when we have done this and placed the details side by side with the details of the other shops, we are enabled to see clearly the relative economic value of the two plants. If we find that the machinery employed on the different processes is essentially the same as in the other shops, we note this point, and turn our attention to the manner in which it is arranged with reference to the sequence of operations, the tools employed on each machine, and the manner in which power is supplied. Then, leaving the plant we examine the means by which the machines are operated; the personnel of the shop. Taking these points, the machines, tools used, their arrangement, manner of driving, auxiliary plant, and labour, let us go into some details.

The machines; are they of the latest and most approved design for the class of work done on them? Is there enough work of the same class to warrant the use or introduction of special machines for its accomplishment, or is work being done on general machines, when by a small alteration in design it could be more profitably operated on by a special machine? The machines may not be of the latest design, but still too good to be put out of action; have any steps been taken to adapt them, and the work to be done on them, so that it shall be produced as efficiently as possible, or is the work put through the machines without regard for economies? Are there a large number of machines of the same type employed, each finishing complete a

piece of work, instead of two or more machines performing a limited number of operations on the same piece of work, and to better advantage? What class of machines is employed; are they of the best obtainable, equipped with time and labour-saving devices, and of the finest and best wearing materials, or are they the cheapest obtainable machines of their class, bought without much regard to their work-producing and upkeep value? What course has been followed in getting the different machines in the shop; when the manager or foreman has advised the purchase of a new machine, has the employer or purchasing agent gone out and bought a machine of the type and size asked for; what reasons influenced his choice; did he buy a machine by this maker because his name was well-known as a builder of first-class machines, or did he purchase it of the other man, as he quoted the lowest price? What did the man who wanted the machine say when he got a machine of the same name and size as he had asked for, but not at all the class of machine he required, or the one best suited to his work; or was he allowed to go and select his machine without regard to initial cost?

What machines have been discarded and placed in the scrap pile in the yard; how long have they been in use; were they displaced because they were worn out, and it would cost more to repair them than to buy a new machine; or, were they thrown out of action because some big improvement in the same type of machine, or some other new type of machine, now made it impracticable to operate the older machine at a profit?

Tools; what practise prevails in this connection? Is the high-speed steel chosen on account of its price per pound, or is the best selected by a comparative trial of the leading brands of steel? How is it used; are the tools issued ready for use from a central tool room, and when worn down returned to be re-dressed and ground? Are tool holders used, so that steel of light section may be employed instead of the common-sized machine tool, and a large amount of tool dressing obviated? Are multiple cutting tools used wherever practicable, and are formed and built up tools and cutters used to finish work?

Boring bars and cutters; do we notice that they are fitted with standard-sized roughing and finishing cutters, hardened and ground, or is a piece of steel of suitable section wedged or held approximately in position by a set screw, and adjusted by taps with a hammer?

Is the work machined to gauges, or does the practise of taking the size from a graduated scale, and machining the corresponding

piece to suit, still prevail? Are all mandrels standard sizes hardened and ground, or has a mandrel to be turned up afresh every time it is wanted?

The arrangement and driving of machines; does the work in process of manufacture progress steadily in one direction, entering in the rough state at one end of the department and emerging finished at the other; are the machines arranged so that the work requires a minimum of handling, machines of the same class being grouped together, the heavy tools arranged in proper sequence and the light tools in suitable groups? Is all the power furnished to a central line shaft, and are the machines placed in rows parallel to this shaft, being driven therefrom?

Is the group system of driving adopted, each group having a short line shaft driven by a separate electric motor, and some of the heavier tools being provided with an individual motor drive?

Auxiliary plant; what is provided in this line? Are the machines placed on a good, solid wood or cement floor? Are there facilities for the catching and removal of cuttings? How is the work handled; are there suitable bogies or boxes which can be easily and quickly moved from the one group to the other, holding many light pieces of work? Are there light overhead jib cranes or runways provided with quick lifting tackle, over the heavier machines, and delivering the finished work direct into the erecting department? Are the heavier tools placed so as to be easily accessible to the overhead traveller and at the same time allow a clear floor space for the erection of work?

Labour; what class of men should be employed on the work—will it pay better to employ skilled men and turn out first-class work, or less skilled men and a lower grade of work, or is the work of such a type that we can employ skilled men to make special tools to be used by unskilled men?

Suppose that we direct our attention to a lathe, one of a group driven from a short line shaft, the shaft motor-driven. We have already gone round the shop and have some idea of the relation in which this machine stands to the rest of the equipment. A shaft is being turned; it seems to be the same as this lot of five lying in front of the machine, two of which are finished. The lathe is on single speed and the machine man devotes his attention to keeping his centers from firing up and sizing the shaft; the feed seems to be coarse and he has not much time to stand. On examining the shafts beside the machine we observe that they are left rough-turned, the shoulders and fillets only being finished; this means that they will be ground to

size on the grinding machine we observed in another group. This lathe is not a modern machine; it is fitted with a gap piece, is screw-cutting, and is supplied with driver, face plate, and chuck. The shafts are not very heavy, and there being but little material to be taken off, the performance of this machine on this piece of work seems to compare very favourably with some of the modern machines. These shafts could probably be machined in a shorter time on a hollow-spindle turret lathe, but there is not enough work to keep one running constantly.

In a larger shop having a big output of work this lathe would perhaps be kept going with work of which there was only one or two pieces at a time, and these not readily handled on a standard machine; or, if there was not enough work of this class and the machine was somewhat worn and requiring adjustment and repair, it might be put out of action, being replaced by a modern machine which might be either a centre lathe and screw-cutting or a chuck lathe, with hollow spindle and turret rest, depending on which fitted in best with the rest of the equipment.

Here is a heavy chuck-lathe; we note that the spindle is hollow, the chuck heavy with wide range of speed, the bed is short, the carriage and turret heavy and fitted with automatic stops. There is not much duplicate work beside this machine, but it is fairly heavy and within range of the chuck; the automatic stops will not be of much use, but the turret carrying five tool holders will save much changing of tools. Alongside we observe some heavy boring bars and sockets, not in use at present, but which will fit into the turret when there is boring to be done. There are also some jig plates having turned projections to fit the hole in the chuck and recessed on the outside to fit some spigot; these will insure accuracy when doing duplicate work which has to be turned on both sides. A vertical boring mill could probably handle some of this work to better advantage.

There is no overhead or jib crane to serve this lathe, a chain block hung from the beams overhead sufficing; this means when putting in or taking out a job that the turner is steadying the work as it slides over the edge of the lathe while the labourer supplies the motive power. Contrast this with a vertical boring mill placed under an overhead traveller; the chuck set ready for the work, the job is slung and dropped into place, leaving the slinger and crane free for other work.

This planer is a fairly heavy machine, two tool boxes on cross rail and one at side of table moving vertically on upright. It is motor-driven, and placed under the overhead crane. There is a fair sized

casting on the table and both tools are cutting; the speed and depth of cut seem to indicate high-speed steel. A box tool holder with two or three tools might make a little better time on the work; there is one lying beside the machine, but it does not seem to be much used. There is no cushioning of the table on this machine and a heavy stress is thrown on belts and motor at each reverse.

This small planer has only one tool holder and to traverse this piece of work will take some time; as this is a small piece one compares the performance with that of a milling machine with face mill taking all the width at one cut, the setting taking practically the same time as on the plane. Where there is a large piece of work to be done the planer will show to better advantage, as the initial cost of a milling machine with its equipment of cutters large enough to handle the range of work is greater; where duplicate work is being done in quantity, the heavy milling machine with vertical spindles and face cutters, or horizontal spindle and ordinary cutters, will machine much more quickly, especially if formed or checked work is being done, when a gang of cutters could be used.

The tendency is to multiply the number of cutting points at work and so to economise time; this is very noticeable in the milling-machine processes where every available surface is being operated on at the same instant, in very many cases special jigs and fixtures being made to hold the work so that every surface in the same plane may be machined at one operation.

On hollow-spindle turret lathes forming pieces from the solid bar, and also on some chuck work, turning and boring operations proceed at the same instant, and with automatic machines the filling of the magazine, or the putting in a length of rod, is all the attention that is necessary. The grinding wheel also by means of its thousands of cutting points, each removing a grain of metal at a very high speed, makes practicable the rapid finishing of work and to very fine limits.

THE USE AND PERFORMANCE OF BELT CONVEYORS.

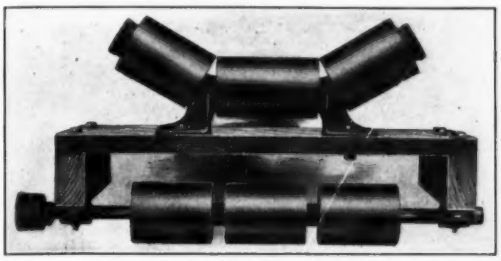
By Werner Boecklin.

Mr. Boecklin's article is noteworthy for the thoroughly practical manner in which he treats the questions of mechanical construction, of care and upkeep, and of economy in operation which are often obscure to users of belt conveyors. It is a useful summary of general working principles and a guide to recognition of the larger problems in which the assistance of the specialist must be obtained.—THE EDITORS.

ECONOMICAL operation is the goal at which the present-day manager must aim. As a result of the necessity and desire to minimize the cost of manufacture, machinery for handling materials economically has received a full share of attention from designers, manufacturers, and users.

As a transporting apparatus the belt conveyor is not new. Before its modern extensive use in all classes of industries it was confined to the transportation of grains in grain elevators. There, as an endless woven cotton band, it was run flat over the simplest of wood pulleys, or idlers. Although the belt conveyor in the evolution from its primal form to the present condition underwent certain modifications, these were more in the nature of changes in detail than in principle.

The original belt conveyor consisted of a very wide belt running on straight idlers and carrying a small amount of material distributed along the middle. As a means of increasing the capacity and preventing spill, by tilting the edges of the belt, the "concentrator," which is a bell-shaped pulley placed at either end of the straight idler, was early applied. This step was a leader to the modern troughed belt, obtained by using a "troughing idler." An important result was accomplished when the troughing idler was invented and placed in service. The capacity of the conveyor was increased without increasing the width of the belt. A troughed belt will carry from two to three times the amount carried by a flat one of the same width. The continuous troughing of the belt, resulting from the use of such idlers, made a higher efficiency possible and one which could not be realized in the old types. Mistakes were made in the early designs of the troughing idlers due to the manufacturer's desire to get more out of the belt than it was capable of giving. A belt having its outer edges

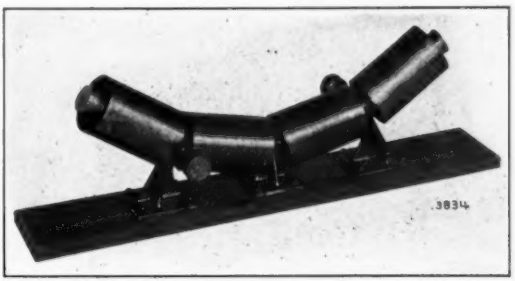


IDLERS FOR BELT CONVEYOR.

All three pulleys are in the same vertical plane, and are centrally lubricated by grease. The shaft is fixed and the pulleys turn. Robins Conveying Belt Co.

tilted to an angle of 45 degrees, the early designers calculated would give more of a trough and hence a greater capacity than one having inclinations of 30 degrees. The first idlers were built with side pulleys at an inclination of 45 degrees, but experience has demonstrated this to be excessive; 35 degrees was standard for a long time, then 30 and 25 were tried and found to give even better results.

There are two general classes of belts used for conveyor purposes, viz, cotton and rubber (so called). Cotton belt consists of 4, 5, 6, 7 or more plies of duck, stitched together and soaked in various oil preparations to make it waterproof and increase its life. Rubber conveying belts are made up of 4, 5, 6, 7 or more plies of cotton duck bound together by a suitable mixture known in the trade as "friction," and having on one side an extra thickness of rubber forming a wearing surface. Care must be exercised in the manufacture of such belting to prevent over-vulcanization of the covering, which should be soft, tough and pliable. The usual thickness of such wearing coat is 1/8 inch, but 3/16 inch and 1/4 inch are called for in some specifications, depending upon the nature of the material to be handled. Patent belts include certain rubber belts in which changes are made in arrangement of plies and rubber as compared with the ordi-



FOUR-ROLL TYPE LINK BELT COMPANY BELT CONVEYOR FOR LARGE CAPACITY.

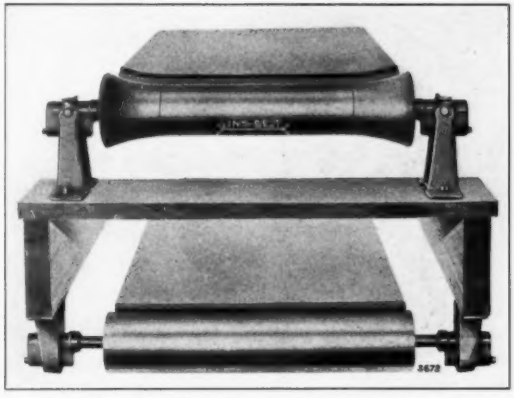
Designed to secure relatively deep troughing without sharp bends.

CONVEYORS FOR MILL TAILINGS AND REFUSE FROM CYANIDE TANKS.

Part of the Knights' Deep and Simmer & Jack East plant. The upper view shows the movable tailings stacker at top of the dump. Jeffrey Manufacturing Co.

nary rubber belt. In one well-known make the middle portions of some of the plies are omitted and the section thus left is filled with the rubber covering, giving an extra reinforcement to this part of the belt. In another patent belt some plies are left out along the bending lines imposed by the troughing idlers, giving the belt greater flexibility at these points.

Different theories are responsible for the two designs. In the case of the first, it is argued that as most of the material is delivered to and carried by the middle portion of the belt, hence this part should have additional reinforcement to withstand the greater wear put upon it. In case of the second, the inventor claims that belts deteriorate more from the effect of bending, with a resulting separation of the plies, and his remedy is therefore to give more flexibility to the belt at the points where it is most needed. Many belts, however, may be found which wear out neither at the center nor along the bend lines, proving that the theories are by no means universally applicable. The rubber covering is often worn down to the cotton along the outer thirds of the belt, the balance remaining in good condition, showing either wrong method of loading or the use of guide idlers or both. It may be stated however that the transverse flexibility secured in the patent belts cause them to hug the central pulley more closely, thus reducing the tendency to run off sideways and doing away with the guide and steering idlers.

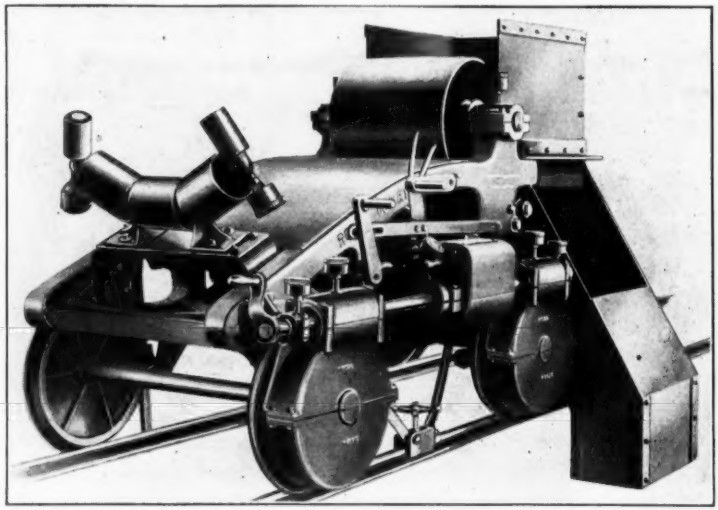


PRESSED-STEEL TROUGHING AND RETURN ROLLS FOR CONVEYOR BELT.

The bell-shaped end sections are flanged on their inner edges so as to overlap the center part snugly. The ends are closed to prevent entry of material. The straight center is designed to act as a one-piece carrying roll, eliminating troughing strain. The Link Belt Co.

Of troughing idlers there are two general types, the straight-line and the offset, and the details for each are various. In the former all pulleys forming the idler have their axes in the same vertical plane;

in the latter the horizontal pulleys are not in the same vertical plane with the inclined or troughing pulleys. Hollow shafts are largely used on which the pulleys run loose, the shafts or tubes being filled with grease which is forced through holes drilled in the shafts by means of compression grease cups. With a solid shaft, self-oiling bearings or ordinary bushed bearings with suitable oiling devices are extensively used. A good design of graphite bearing would be found satisfactory in many localities, and friction may be still further reduced by the use of ball bearings as manufactured by one company for belt-conveyor purposes.

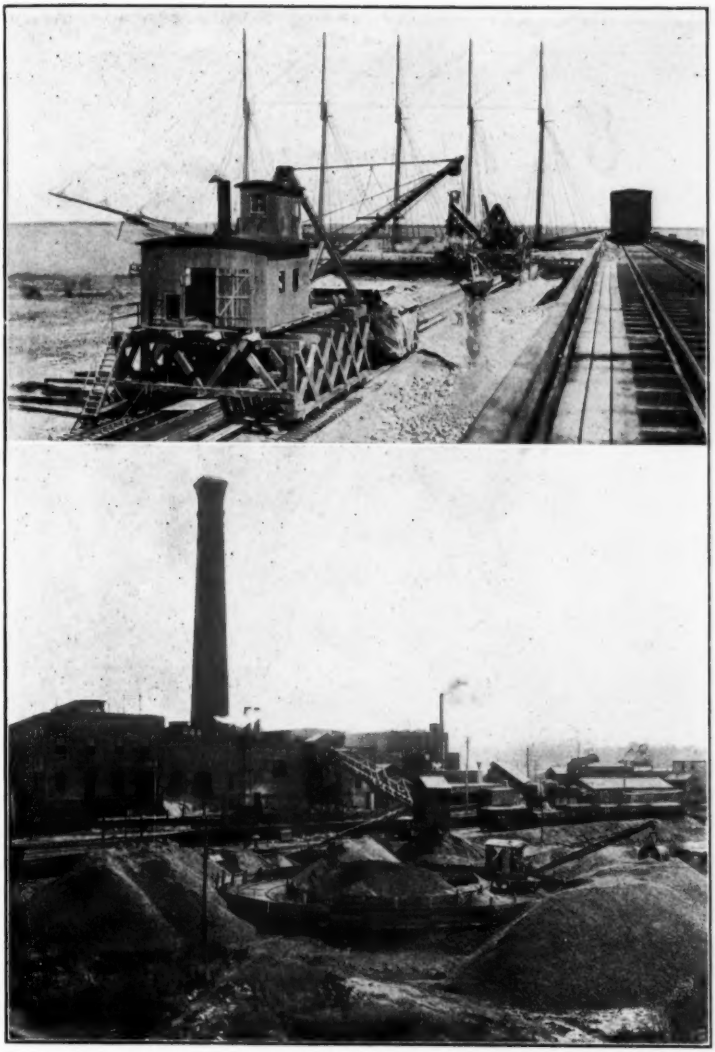


TRIPPER FOR BELT CONVEYOR.

Automatically reversing, or may be clamped to the track. Robins Conveying Belt Co.

Troughing idlers are spaced about 3½ feet centers in case of large conveyors to 6 feet centers for the smaller ones. The return idlers may be spaced 10, 12, or even 15 feet apart, depending upon local conditions. Guide idlers are small pulleys with their stands placed at intervals along the conveyor to prevent the skidding of the belt sideways.

Trippers, which are designed to discharge the load at any convenient point along the length of the conveyor, are of two types, stationary and movable; the latter may be either hand-propelled or self-propelling. The essential parts consist of two pulleys placed approximately one above the other with their shafts running in suitable



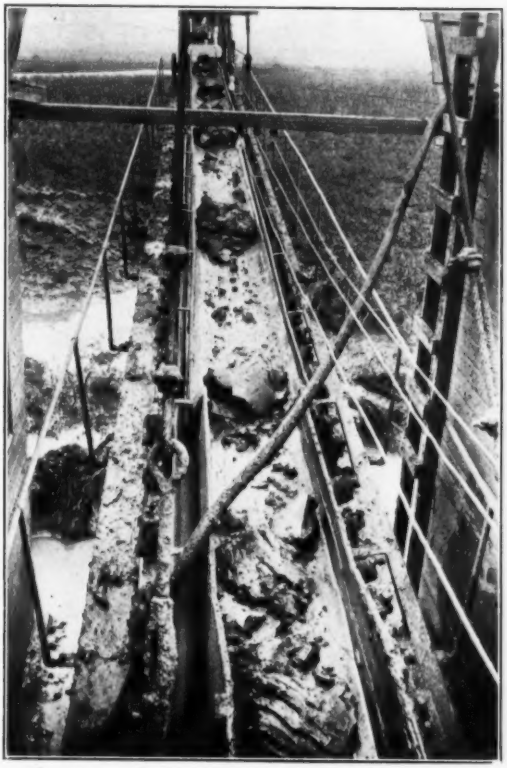
HANDLING MATERIALS WITH HAYWARD BUCKET AND ROBINS CONVEYING BELT.

The picture above illustrates loading of sulphur; the Hayward traveling excavators with orange-peel buckets deliver to conveyors centrally located under the machines, and thence to the vessel. The lower view shows the coal-handling system of the Syracuse Lighting Co., installed by the Robins Conveying Belt Co. and using the Hayward Co. 1½ cu. yd. bucket, with many novel features.

A BELT-CONVEYOR ORE-HANDLING PLANT FOR A LARGE MINE.

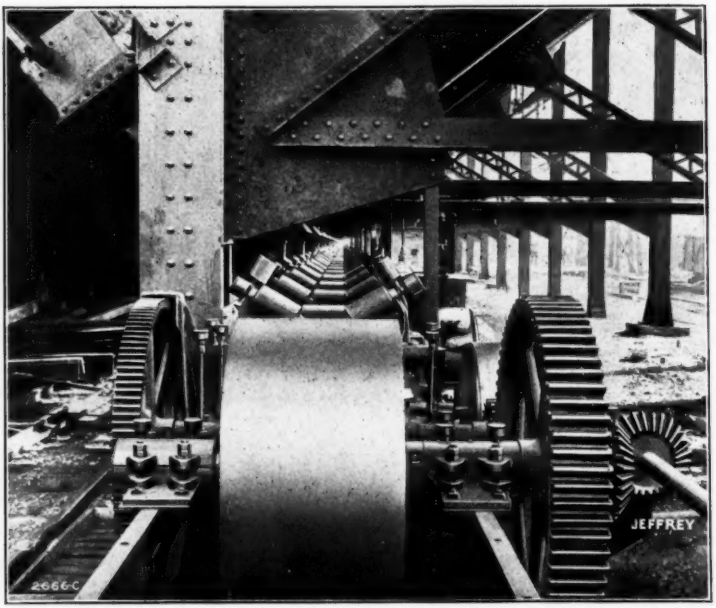
The 30-inch cross conveyor, loaded through a steel-apron feeder by a 3-ton skip, delivers to either of the long 30-inch conveyors. These are each 330 ft. in length. Automatic self-reversing trippers distribute the ore uniformly to the cars; steel deflecting plates prevent ore from falling between the cars. Stephens-Adamson Mfg. Co.

bearings, all supported on a frame. The upper belt is led around the pulleys in the form of a letter S, resulting in throwing the material free from the belt, whence it is conducted to one or both sides by chutes. The hand-propelled tripper is moved from point to point along a tripper track by means of a hand crank. In the self-propelled machine power is transmitted by gearing or sprocket chain from the conveyor belt to the truck wheels. By utilizing the opposite directions of rotation of the two principal pulleys, the tripper is driven in either direction. Attachments on the tripper make it self-reversing.



A 36-INCH CONVEYOR CARRYING MATERIAL FROM A DREDGE.
The huge "chunks" are handled as they come from the dredge bucket. Stephens-Adamson Mfg. Co., Aurora, Ill.

In designing a belt conveyor the first question presenting itself is, what is the required capacity? Capacity depends upon two factors, speed and width of belt. Moderate speeds when practicable are advisable, as (other conditions remaining the same) belts wear longer than when run at high speeds; 300 or 400 feet per minute are considered moderate belt speeds and 700 or 800 feet per minute are high. Narrow belts can not be run at speeds possible with wide belts. Thus certain limiting speeds have come to be recognized and adopted as a working basis. These are given in the table on the next page.



COKE-HANDLING CONVEYOR FOR THE TENNESSEE COAL, IRON & RAILWAY CO., ENSLEY, ALA.

Jeffrey rubber belt, 1032 ft. long between terminal pulleys. Photographed during construction, showing idlers and drivers.

As the result of long experience with belt-conveyor drivers, certain diameters for driving pulley have been adopted as minimum. As a guide in the design of drives the following sizes, used by one of the leading manufacturers, are also given in the table.

LIMITING SPEEDS OF BELT CONVEYORS.

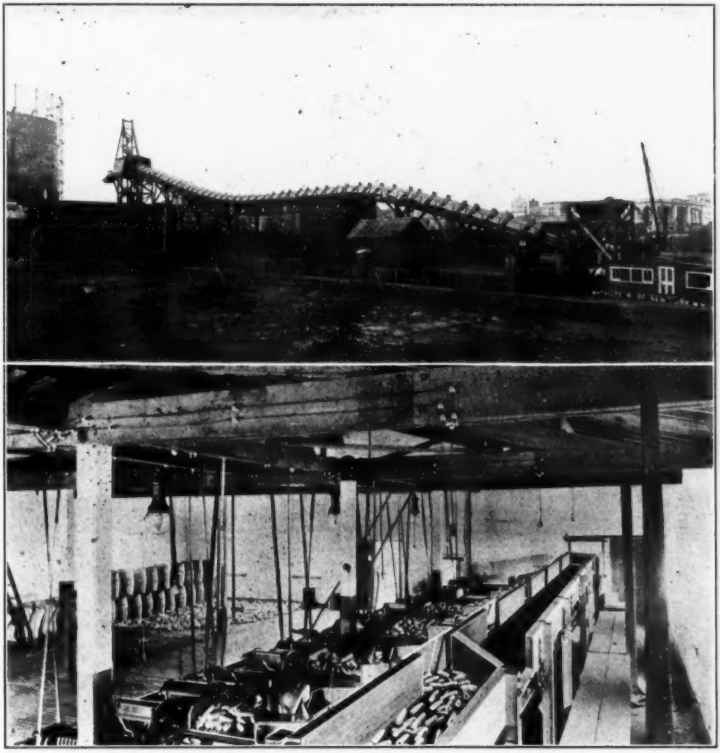
Width of Belt.	Speed, Feet per Min.
12 inches	350
16 "	400
20 "	450
24 "	500
30 "	600
36 "	700
42 "	725
48 "	750
60 "	800

For	12	and	14	inch	belts,	minimum	diameter	driving	pulley	16 inches.
"	16	to	24	"	"	"	"	"	"	20 "
"	26	to	36	"	"	"	"	"	"	30 "

As the lengths increase and the power required to drive becomes greater, a tandem arrangement of pulleys is often resorted to. By running the belt over two pulleys connected by a pair of gears, the in-

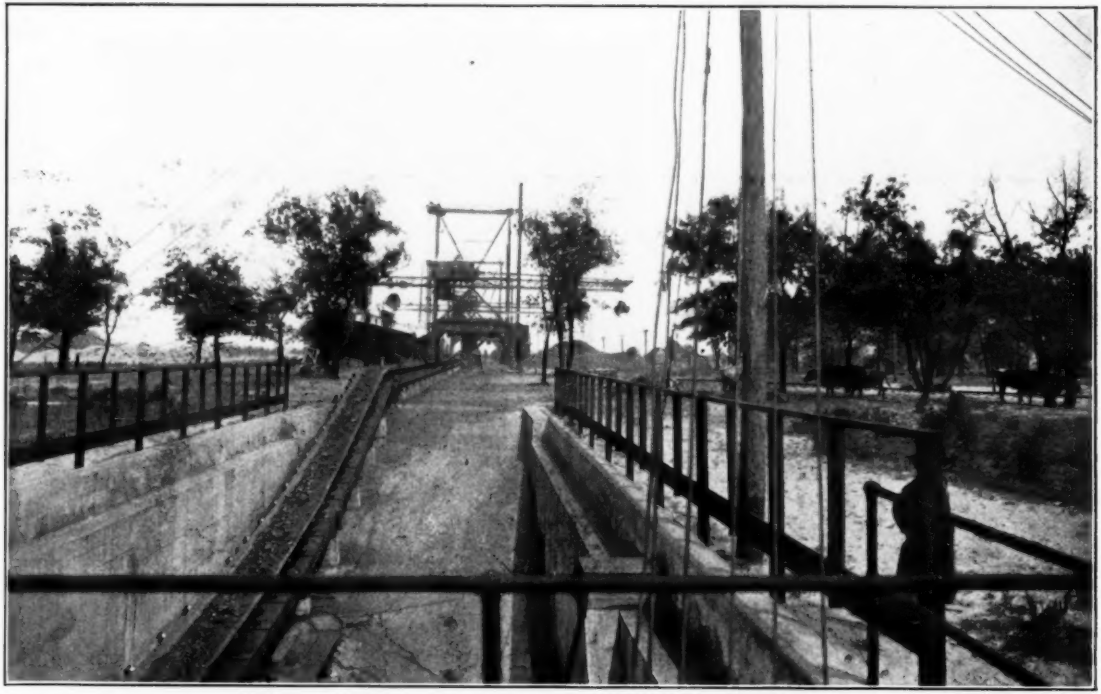
creased friction adds materially to the efficiency of the drive. In order to keep down the diameter of the driving pulley, lagging is frequently resorted to thereby increasing the coefficient of friction between the belt and the face of the pulley.

The horse power required to operate a belt conveyor depends upon the length, width, and weight of belt, whether run horizontal or inclined, weight of material carried, type of idler used, and general condition of machinery. The size and weight of belt and the weight of material are all factors producing the friction resistance of the idlers carrying the belt, and therefore have a direct effect upon the pull. The frictional resistance is modified to a certain degree by the kind of bear-



BELT CONVEYORS IN INDOOR AND OUTDOOR INSTALLATIONS.

The view above shows a 325-ft. 30-inch housed belt conveyor with pressed steel rolls, coke-receiving station of Astoria Heat & Power Co., N. Y.; capacity 60 tons an hour. The lower is of a 22-inch flat belt conveyor for handling corn; hinged sections of the trough side deflect the ears to the cutting-machine bins. The Link Belt Company, Nicetown, Pa.



A 36-INCH CONVEYOR TAKING COAL FROM TWO FAST UNLOADING PLANTS.

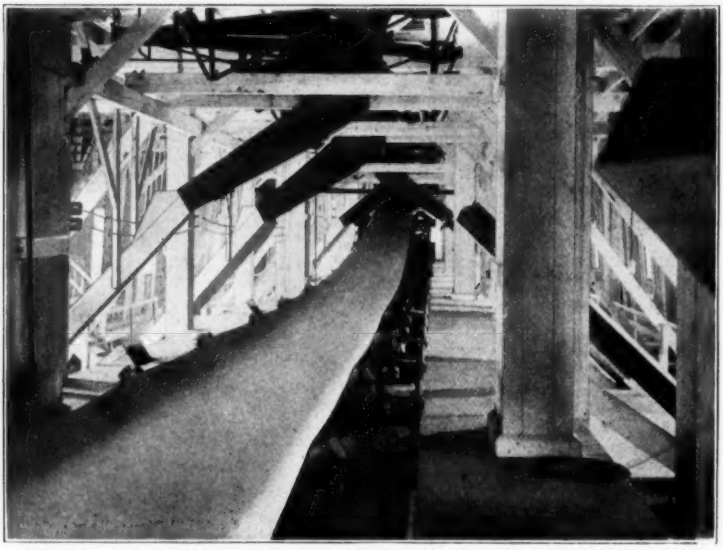
The two unloaders deliver simultaneously to the conveyor at the rate of about 700 tons per hour. The conveyor dips under six railroad tracks and connects with conveyors and stocking bridge aggregating more than ½ mile in length. The space to the right is reserved for an additional installation bringing the plant up to 1500 tons per hour. Installed for the By-Products Coke Corporation, South Chicago, Ill., by the Robins Conveying Belt Co.

JEFFREY BELT CONVEYOR DISTRIBUTING STONE INTO STORAGE BINS.

ings used on the idlers thus affecting the pull upon the belt. An inclined conveyor imposes an additional factor, that of lifting the material, which presents the ordinary problem of pounds lifted in feet per minute.

The amount of power needed to operate a belt conveyor is always so small, when measured by the capacity, that ultra-refinements in equipment in order to cut down power seem wasted. Manufacturers often emphasize the heavy strains induced in belts by the inferior type of idlers used. A specific case will throw some light on this subject. A 24-inch belt 300 feet long carrying coal and running horizontally at a speed of 400 feet, requires about 15 horse-power to operate. The effective pull from belt formula:

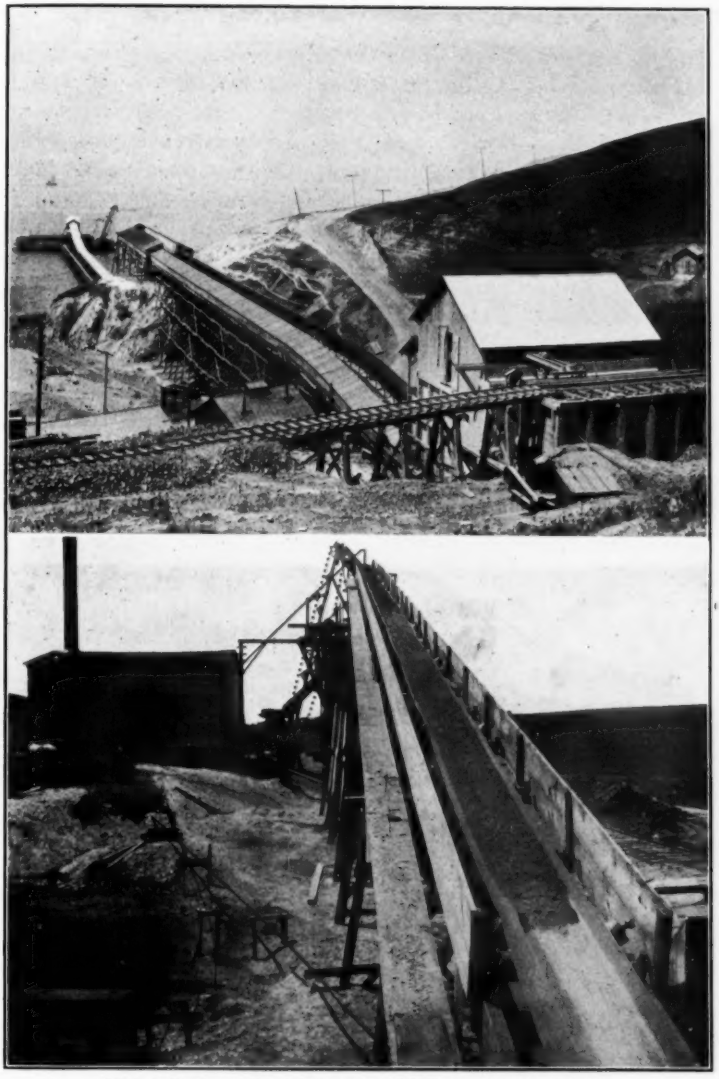
$$\text{Pull} \times \text{Speed} = \text{H. P.} \times 33{,}000, \text{ equals } 1{,}237 \text{ pounds.}$$



WEBSTER 40-INCH REVERSIBLE BELT CONVEYOR, 310-FEET CENTERS FOR GRAIN ELEVATOR.

Assuming the maximum pull on the working side of belt at 25 per cent higher than effective pull, the greatest strain on the belt is 1,546 pounds. Figuring on the basis of a four-ply belt, the ultimate strength of which is about 1,000 pounds per inch of width, the breaking load of the belt in question is 24,000 pounds and the factor of safety amounts to 16, which is a large enough margin for the poorest sort of idler.

Belt conveyors are designed to run in three ways; horizontal,



BELT CONVEYORS FOR HANDLING CRUSHED STONE AND SAND.

Above is the plant of the San Pablo Quarry Co., California. Two 16-inch conveyors 600 ft. long carry the stone from the crusher house to storage bunkers blasted out of the rock. Thence two 20-inch conveyors 750 ft. long, with a capacity of 150 tons an hour each, carry the stone to the barge. These conveyors receive the stone through special feed hoppers. Below is a 20-inch conveyor carrying sand.
Stephens-Adamson Co.

straight incline, and in a vertical curve. Experience has demonstrated that materials such as coal, grain, stone, and sand can be conveyed on inclinations from 20 degrees to 25 degrees. Lump material tends to roll back, but this tendency is stopped when there is an admixture of fine and lump. The nature of the material will determine, therefore, the amount of inclination possible. The vertical-curve lay-out is frequently employed to advantage. The minimum radius which can be adopted depends upon the weight of belt, weight of material, and amount of slack in the belt. No satisfactory mathematical treatment can be accorded this problem. I have adopted a radius of 100 feet with satisfactory working results. Of course a conveyor will operate with vertical curves of smaller radii, the belt running as much as two feet above the idlers when light and falling to position as the load comes along.

The unit cost of handling materials by means of belt conveyors varies according to conditions, but remarkably low costs are obtained in many instances. The examination of data taken from several hundred installations shows figures as low as $0.0025 and $0.0020 per ton conveyed 100 feet. This includes power, maintenance, depreciation, and interest on investment.

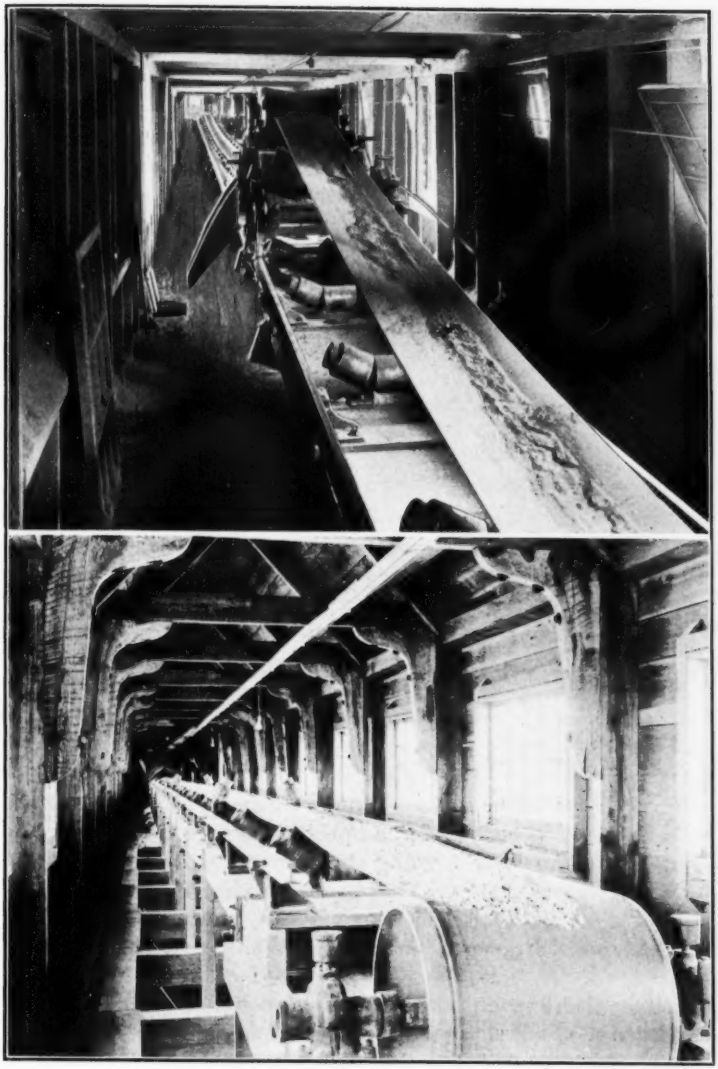
The following points relating to operation suggest themselves as of particular interest to owners:

First. A high-grade belt although costing more in the beginning lasts longer and gives better satisfaction than a cheap belt.

Second. It is best to put conveyors under cover if the installation is to be a permanent one. Rain, snow and ice are not conducive to long life for any sort of machinery. Water may get between the plies, and freezing, force them apart; frost getting into the idlers prevents them from turning, and when the power is applied, the belt (if it can be moved at all) has an excessive strain thrown upon it, with bad results. By covering the conveyor, better attention will be paid to oiling than if in the open exposed to all sorts of weather. In high exposed positions, winds must be taken into consideration, for not only is the material being transported blown off an exposed belt, but the belt itself is often lifted off the troughing idlers and forced over to one side.

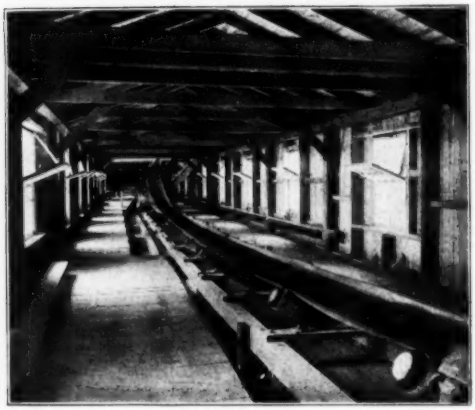
Third. The inclination of troughing idlers should not be excessive; 25 degrees is about the correct slant to which the edge of a belt may be subjected without undue bending and stretching of the plies. As a result of excessive bending, the plies buckle and separate, thus quickly destroying the belt.

Fourth. If possible, all guide idlers should be dispensed with.



HANDLING MATERIALS BY ROBINS BELT CONVEYORS.

The upper installation handles cement at the plant of the Marquette Portland Cement Co.; the lower carries wood chips at the paper mill of the West Virginia Pulp and Paper Co. Both by the Robins Conveying Belt Co.



WEBSTER BELT CONVEYOR OPERATING IN CEMENT PLANT.

Where belts refuse to run straight and guides are put in to keep them in line, the edges rubbing against the guides are quickly injured, the cotton duck being exposed and the plies torn apart. To prevent skidding of belt, a simple device is employed consisting of what is known as a "steering idler." This consists essentially of a standard troughing idler centrally pivoted and having two arms extending to each side of the belt, which carry small steering pulleys. As the belt starts to skew and comes against a steering pulley this turns the troughing idler about its center sufficiently to induce an opposite sideways movement of the belt, which is thus made to line itself automatically and by means of friction at the middle rather than by pressure against the edges as in the old type of guides.

Fifth. Delivery chutes are often a source of undue belt wear. Pieces of iron, or rock, becoming lodged between the edge of the chute and the belt, often do considerable damage before power can be cut off. The design of delivery chutes deserves more attention than is usually accorded the subject. They are almost invariably made too wide and the skirt boards instead of diverging slightly are made parallel. Chutes should deliver the material to the belt in the direction in which the conveyor is traveling, thus giving the material a certain amount of initial velocity which preferably is equal to that of the belt. There is also less tendency to spill when the conveyor is loaded in this manner.

Sixth. Belt conveyors will not carry hot or wet materials, or material giving chemical reactions, without frequent renewals. Where such materials are to be handled by belts the higher-grade ones give better results.

Seventh. Proper supervision is important in the economical operation of any kind of machinery, and continual attention in the case of belt conveyors will reward the owner in the form of fewer shut downs and renewals of parts.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTING.

By C. E. Knoeppel.

III. THE ELEMENTS ENTERING INTO PRODUCTION COSTS.

Mr. Knoeppel's series began in the October issue of THE ENGINEERING MAGAZINE with an outline of the simple elements of the problem of foundry costing. Last month he dealt with the importance of correct burden apportionment. In the present instalment he enumerates and classifies the elements entering into production costs. His discussion next month will show how the various items are grouped and how and why they are apportioned to product.—THE EDITORS.

WHEN times are prosperous and money "easy," a manufacturer is usually too busy with details to which attention *must* be given, to give the matter of increased efficiency the consideration it is entitled to and should receive. Production is at a high point, the percentage of profit gratifying, with the result that the management cannot quite see the necessity for introducing methods that have for their ultimate purpose the bettering of results that are, or seem to be, satisfactory. Possible leaks seem insignificant, so satisfied is the management with what is an apparent accomplishment.

Just as soon, however, as a period of depression makes itself felt in the way of a falling off in sales, perhaps at decreased prices, this feeling of satisfaction becomes one of uneasiness—the management realizing that costs increase and profits decrease as the volume of sales decreases, and that prices cannot be increased on account of the fact that any increase in price at such a time would likely result in a still further falling off in sales which, under the conditions, would be most disastrous. At such a time, a full and complete knowledge of the pertinent details would be of inestimable value to the management, as it would assist materially in keeping costs down to as low a figure as possible, besides showing what might be done toward increasing the productivity of the plant; consequently there is regret that more efficient methods were not introduced at a time when business was more prosperous. Concentration of endeavor is one of the roads to success —if it is known *where* to concentrate.

The maintenance of price does not imply a maintenance of profit. Careful buying may result in a lower cost for direct materials, and proper supervision may reduce the cost per 100 pounds for direct

labor, but the best of management cannot expect to reduce the overhead expenses or "burden" in proportion to the reduction in the volume of production. As a result we find that burden costs increase as the output decreases, any increase in cost affecting profit as the following will show:—

	A	B	C	D
Monthly tonnage	250	200	150	100
Monthly burden	$5,000	$5,000	$4,000	$4,000
Direct material per 100 lb.	$1.00	$1.00	$1.00	$1.00
Direct labor per 100 lb.	.75	.75	.75	.75
Prime cost	$1.75	$1.75	$1.75	$1.75
Burden per 100 lb.	1.00	1.25	1.40	2.00
Total cost per 100 lb.	$2.75	$3.00	$3.15	$3.75
Selling price per 100 lb.	3.00	3.00	3.00	3.00
Profit per 100 lb.	.25	....	....	....
Loss per 100 lb.	....	....	.15	.75
Per cent of burden to direct labor	133⅓	166⅔	186⅔	266⅔

It can be seen from this table that the item of "burden" has considerable to do with the amount of profit, that there is a certain point in the amount produced where *income balances cost*, and that profits as well as losses begin from this point. *Do you know where it is in your business?*

A shrewd manager recently stated that his designer once handed him the design covering a proposed addition to one of the main factory buildings, with the petition that he approve it at once so that the work could be started, stating that the plan as set forth by the design had been looked over by several and approved by them. The manager looked at it for a moment and laid it on his desk with the remark that he would decide later in the day as to its merits. This rather incensed the designer, who stated that he felt the manager qualified to reach a decision from the facts as set forth by the design, and that the desire to postpone the decision was really a reflection on his ability as a designer. The manager replied by saying that as far as he could see, the design covered the ground in a satisfactory manner; but that he was less concerned with what *was* shown on the design than he was with what had *not* been shown at all, which would have to be considered before an intelligent decision could be reached. The manager told me that in going over the design later in the day, he found that it failed to consider several important points—that it did not take into consideration the future growth and expansion of the business; consequently the design had to be revised, the

revision eventually saving the company in question considerable money, due to nothing but a search for points that had not been covered.

What you are doing is apparent and evident; but it is what you are *not* doing that should receive your careful attention. *Appoint yourself a court of investigation, issue to yourself an order to show cause why your methods should not be discarded on account of their inability to secure you, through their use, maximum results at a minimum outlay.* In the preparation of your defense, you will undoubtedly be surprised at the large amount of information you will gather as you investigate the merits of your methods. You may start out with the feeling that they meet all requirements, but in actually defending them you will begin to see that here, there, and elsewhere there are weak places—strings which lead to nowhere in particular, points not covered at all, inaccuracies, and many other faults which render efficient costing out of the question. Even though you find but few serious faults, you will discover enough to warrant the investigation.

Be dissatisfied. Records are made only to be broken. Rejoicing over the accomplishment of some particular ambition is right and proper if it is not at a sacrifice of your determination to make each success a stepping stone to a still greater success. If your foreman tells you that you are getting 500 pounds per day per man of a certain class of product, strive for 600 pounds, and even if you are not able to secure this amount you might get 550 pounds—at any rate, an effort will be made, and it is effort that counts in these days.

Success in any branch of endeavor does not just "happen," but is rather the result of intelligent oversight and supervision. If the owner of a foundry business could be the moulder, core maker, melter, business getter, book keeper, and executive combined, all would be well; but as this is impossible, the foundry executive must depend upon as intelligent an assistance as is possible to secure—succeeding or failing, according to the efficiency or inefficiency of this assistance. Methods, men, clerks, etc., are simply "tools" which can be used to decided advantage or to no real purpose at the will of the executive, and it should be his duty to see to it, first, that these tools are what they should be, and second, that they are used to advantage. This duty the executive owes to himself, to his business in particular, to his industry in general.

Looking at the matter from a standpoint purely financial, the investment is the item which influences success or failure; and made up (as it is) of every conceivable kind of expenditure, it needs the most

careful watching in order that the returns shall include a fair margin of profit on this investment. If you purchase a knife at a hardware store for 75 cents and induce some one to purchase it from you for $1.00, you have made 25 cents on your investment, or 33 1-3 per cent. If you purchase pig and scrap irons, coke, the services of moulders, core makers, cleaners, laborers, supervision, clerical help, materials, and supplies, and sell the resulting product of this investment to several people, you must see to it that you charge each one enough to cover your investment and at the same time allow yourself a margin for your efforts. If after taking care of this investment you find that you have been able to deposit a reasonable amount to your credit, you have a right to feel that you have successfully conducted operations. This success is an effect; something contributed to it, and what this something was and why it assisted you is entitled to more than passing attention, for if you can ascertain the reasons and properly classify, tag and file them away for future reference, you have at your disposal a means of forestalling disaster. If, on the other hand, you had found, after meeting your obligations, that you were on the wrong side of the books, you would without any question want to know what the causes were; but unless you had at your command some means for assisting you in your search, you would be forced to spend considerable time in an endeavor to pick past performances to pieces before locating your trouble, and the chances are that at best you would get only a general idea of what you desired to ascertain.

Any manufacturing enterprise is one of countless details, even though results can be expressed in very few figures; and considering everything expended as "expenses," the end in view of the manufacturer being to keep them within a reasonable margin of the "receipts," it stands to reason that each and every one of these details—having as it has, a direct influence on the ultimate results—is entitled to most careful consideration, either separately or collectively. The well known maxim—"everything occurring and coming up in a business is important" should be of highest significance to every manufacturer.

A man in the act of putting his hand in his pocket for his knife was asked why he did so. He replied by saying that he did not know, but believed that his head told his hand to do so. When asked why his head suggested such a procedure, his reply was, "my head knew that the knife would not come to my hand, so it sent my hand after the knife." Putting this same bit of logic in another way, we have—"details will not come to the executive, so the executive must send something after the details."

Expenses (details in the aggregate) are either conservative or beyond all reason—legitimate or illegitimate; the executive must therefore provide himself with some method which from time to time will acquaint him with these details properly classified, so as to enable him to keep his fingers on the pulse of the business and ascertain its condition. Chemistry of bodies undertakes their resolving into component parts while "Chemistry of Costs" undertakes the resolving of facts and information into the elements necessary for arriving at result-producing conclusions. It is evident to all, however, that we cannot separate that which has not been grouped, hence the necessity for logically joining together the pertinent details of a business. This joining or grouping we will term "synthesis," which may be defined as:

> The process of automatically grouping together the various details of like nature, which when properly arranged and classified, will show, at stated periods, what has been expended or accomplished.

The resolving of results, which we will term "analysis," may be defined as:

> The process of separating and placing by themselves the various details of like nature, which when contrasted or compared with the details of the same nature for previous periods, will enable the executive, through the instrumentality of thought and deduction, to determine whether results are as they should be or not, or to reach a definite conclusion regarding a policy.

It has been well said, "complexity breeds perplexity." This is especially so in the case of a foundryman who has been the recipient of repeated reminders, in one form or another, that things are not as they should be. How low can I consistently bid? Where is my money going? What can I do at different productions? These are some of the questions that the foundryman will ask himself, realizing that to turn a loss into a profit, or to increase his profits, he must either increase his prices or decrease his cost of producing castings; but as competition is such as admits of no increase in prices, his cost information is the something upon which he must concentrate his attention. He finds, however, that in the absence of a well organized means for furnishing pertinent details this information can be given to him only in a general way, and that it will be rather a difficult task to answer the self-imposed questions to his entire satisfaction. He therefore determines to find out what he wants to know,

but is confronted with what seems to him to be a problem more or less complex. As a starting point, however, he decides to arrange for a careful monthly accounting of his expenditures, giving the various details proper consideration and bearing in mind that there are three principal elements in production cost—A—Materials, B—Labor, C—Expenses—he sets out, in a receptive mood, for impressions to assist him in his work, making proper notations as he decides on methods of procedure.

In the first place, he notices in going through the foundry at casting time that he has certain materials going through a melting process before castings are produced, these materials being the pig irons, purchased iron and steel scraps, his own or home scrap (comprising bad castings made in the shop, gates, sprues, shot, and over-iron), and the coke necessary to melt the iron. He knows that in the core room they are using a coke inferior to that charged into the cupola, and that to operate his plant he is forced to buy coal for power. Earlier in the day, when the moulders and core makers were putting up their work, the fact that sand was used by them suggested the two kinds used—moulding and core sands; also that a miscellaneous lot of materials were being used by the men throughout the plant, such as chaplets, hammers, brooms, brushes, facing, oils, iron and wire, bolts and nuts, etc., all of which he decides to call "stores," before they are delivered to the men and "supplies" when delivered to them. To control his item of materials properly, he decided that it can best be handled by giving each kind of material a separate number, opening an account with it on his books, charging it with what is received and crediting it with whatever is consumed, arranging at the same time to take care of adjustments that may be necessary, the following being an exhibit of his material accounts:

Account Number.	Name of Account.
100 to 114	Various pig irons purchased.
115	Scrap iron—purchased.
116	Scrap steel—purchased.
117	Home scrap—bad castings and remelt.
118	Core sand.
119	Moulding sand.
120	Foundry coke.
121	Stock coke.
122	Coal.
123	Stores.
130	Material adjustments.

In studying the conditions more closely, he observes that there are many things being done by his men which if classified and tagged would provide a means for acquainting him with the channels

through which his money passes. He notices laborers digging pits, ramming up, and in other ways assisting the moulders; that some of them have regular helpers; that there are apprentices at work; that certain men are operating moulding machines, and that a part of this work which he calls "moulding" is given up to cutting sand, pouring off, and shaking out. The moulding process naturally suggests core making as a separate operation, while the cleaning of the castings suggests another, and as he notices that considerable chipping is necessary before castings are in a condition for inspection and shipment, he decides that it would be well for information purposes, to keep this item separate from the cleaning of castings.

He carefully watches the laboring men working around the cupola, in the yard, around the shops, at night getting out the work, etc., making notes as he does so; he sees that considerable is expended to replace castings that have not been accepted by the inspector, which according to his way of looking at it is information he should have in deciding as to the efficiency of his men; and while he knows that he expends quite a little for supervision and clerical work, he decides in favor of keeping this item separate so as to tell, periodically, just what this amounts to without having it looked up for him. As before stated, he has notice that quite an amount of miscellaneous materials is being used by the men around the plant, and as it is his desire to place each department upon its own footing, he concludes to charge them with the supplies they use in a given period of time, which information he can use for purposes of comparison and analysis, in this way perhaps reducing the consumption of the indirect or expense materials.

He finds it necessary to repair one of the factory buildings; this suggests a logical division of the expenditures for maintaining his plant, instead of depending upon one total at the end of the year, which really tells him nothing regarding where the money went and what required the most or repeated repairing or replacing. As he has several departments such as his stable, power plant, pattern, machine, carpenter and blacksmith shops, pattern storage and shipping rooms, he decides in favor of keeping separate the expenses of operating them, so as to enable him to keep in closer touch with the details of his business.

In watching his shop operations, he notices that some lifting plates are being made in order to facilitate the making of a particular order; this suggests to him an account that would tell him what it costs to rig up for special or new work. He decides to charge this

expense for rigging against the work necessitating the expenditures —as a direct charge—at the same time providing a place in his expense account for this item, apportioning to his product the difference between the total expenses and the rigging expense, the advantages of which are that while each order is charged with its proper rigging cost, the rigging expense is *in total* in a place by itself—in this way facilitating study and analysis; and as it appears in the burden statement as a memorandum charge only, he is in a position to take this expenditure into consideration when estimating on new or special work.

The item of salaries he divides into officers' and office salaries; traveling expense into sales traveling and general traveling; donations and dues perhaps amount to enough to warrant him in keeping this item separate, and in this way he goes through each class of expenditure like taxes, insurance, depreciation, legal expense, office expense, commissions, allowances, etc., but before finishing his preliminary work he happens to see some credits to customers for defective castings returned, and while heretofore he has credited his customers and charged his sales—thereby reducing his sales or revenue account—he decides to open an account which he calls "defective castings," crediting his customers the same as before, but charging his scrap account with the scrap value of the castings returned and his defective castings account with the difference between the scrap value and the invoice amount. He decides this way because first of all he wants some means that will bring to his attention, automatically, the amount of defectives returned, so that he may concentrate his endeavors along the lines necessary to keep the item down to as low a figure as possible, and because it is hardly fair to reduce the sales of one month by work that was credited to the sales account several months before. If the sales this month are $50,000, the business is entitled to this credit despite the fact that castings to the invoice value of $2,000, invoiced three months ago when the sales were $40,000, are returned this month. We cannot reduce the sales of three months ago; the defectives returned have nothing whatever to do with this month's business, and as the $2,000 in credits to the customers is a *loss,* less the scrap value, the logical plan is to place this item where it will *plainly show as a loss.* In effect both methods are the same as regards "net income"; for by charging sales with returns, we reduce income but allow costs to remain as they are, while by charging cost with the returns, we increase cost but allow income to remain as it stands, so that the net income would be alike in either

case. It seems, however, that there is more justice in the latter method with the decided advantage of providing the executive with the best kind of danger signal.

After deciding on the various items that he wants to keep track of, the foundryman opens an account with each one, giving each an account number to which can be posted the various expenditures. His first consideration after taking care of his materials, as was explained heretofore, is to separate his labor into "direct labor" and "expense labor"—under the first classification placing:—

MOULDING.—*Account No.* 150—which is to include all time of:
- Moulders.
- Moulders' helpers.
- Apprentices.
- Moulding machine operators.
- Laborers digging pits.
- Laborers ramming up.
- Cutting sand.
- Pouring off and shaking out.

CORE MAKING.—*Account No.* 151—which is to include all time of:
- Core makers.
- Core makers' helpers.
- Oven tenders.
- Mixers and pasters.

Under the second classification—expense account—he will include:

CUPOLA LABOR.—*Account No.* 152—to include all labor:
- Getting materials from yard to charging platform.
- Weighing and placing charges.
- Taking bad castings and remelt to charging platform.
- Charging and tending cupolas.
- Breaking stock.
- Cleaning and daubing ladles.
- Cleaning and preparing cupolas for each day's heat.

CLEANING.—*Account No.* 153—to include all labor:
- Cleaning and grinding castings.
- Tending rattlers.
- Pickling castings.
- Using sand blast.

CHIPPING.—*Account No.* 154—to include all labor chipping and getting castings in condition for inspection and shipment.

HANDLING MATERIALS.—*Account No.* 155—to include labor unloading, stacking and piling of:
- Pig and scrap irons.
- Coal and coke.
- Sea coal.
- Fire clay and brick.
- Limestone.
- Core flour.
- Lumber and slab wood.
- Moulding and core sands.
- Other materials not specified above.

YARD.—*Account No.* 156—to include labor loading dirt cars, cleaning up yard, etc.

SHOP SUPERVISION AND CLERICAL.—*Account No.* 157—to include salaries and wages of:
Superintendent.
Foremen.
Shop clerks.

REPLACE LABOR.—*Account No.* 158—to include labor in foundry or core room replacing work lost or extra work done on account of causes other than faulty design or construction of patterns.

FOUNDRY GENERAL—*Account No.* 159—to include time of all laborers (when not acting as moulders' helpers) working around foundry or core room:
Cleaning up floors.
Carrying out scrap and castings.
Carrying iron.
Shifting weights.
Going after supplies.
Carrying flasks, patterns and cores.
Time of—
Watchman.
Crane men.
Any incidental work not specified above.

NIGHT GANG.—*Account No.* 160—to include all time of laborers:
Taking out castings.
Placing flasks.
Removing gaggers and clamps from sand.
Fixing sand and getting floors in condition for use by moulders when they arrive in the morning.

The third element—expense—is divided into Supplies, Maintenance, Departmental, Miscellaneous Shop and the Commercial expenses, as follows:

SUPPLIES.

FOUNDRY SUPPLIES.—*Account No.* 165—to include all supplies used by the foundry which cannot be charged directly to any one order such as:
Moulding sands, charcoal, stock coke, brushes and brooms, pails, bellows, files, nails and spikes, hammers and hammer handles, torch oils, chaplets, riddles, shovels, iron and wire, facings, parting, bolts, nuts, screws, buckets, torches, wicking, cement, mallets, sledges, wheel barrows, waste and any other incidental materials used as supplies in the foundry.

CORE ROOM SUPPLIES.—*Account No.* 166—to include all supplies used by the core room which cannot be charged directly to any one order such as:
Stock coke, moulding sand, core sand, core oils, molasses, paper, bolts and nuts, files, slab wood, wire and rods, core wash and core compounds, flour, gravel, brushes and brooms, nails, bellows, wheel barrows, wax tapers and other miscellaneous supplies used by the core room.

CUPOLA SUPPLIES.—*Account No.* 167—to include all supplies not otherwise chargeable such as:
Sand, slab wood, alloys, gravel, clay, limestone, wheel barrows, shovels, coke forks, coke baskets, brooms, tapping bars and any other materials used as supplies around the cupola.

CLEANING ROOM SUPPLIES.—*Account No.* 168—to include supplies such as:
Brushes, shovels, wheel barrows, brooms, chisels, hammers and hammer handles, carbo blocks, etc.

MAINTENANCE.

BUILDINGS AND REAL ESTATE—*Account No.* 170—to include all labor spent and materials used in repairing:

Buildings, roofs, fences, sidewalks, tracks, etc.

PLANT EQUIPMENT.—*Account No.* 171—to include all labor spent and materials used in repairing:

Cupolas, blowers, moulding machines, cranes, grinding, rattling and sand blast machinery, elevators, air equipment, pattern, machine, carpenter and blacksmith shop equipments, the stable equipment, etc.

POWER AND TRANSMISSION.—*Account No.* 172—to include all labor spent and materials used in repairing:

Boilers, engines, compressors, dynamos, lights, line and counter shafting, boxes, hangers, belts, pulleys, brackets, etc.

CAST EQUIPMENT.—*Account No.* 173—to include all labor spent and materials used in making:

Stars, clamps, gaggers, braces, bench and flask weights, etc.

PATTERNS.—*Account No.* 174—to include all labor spent and materials used in repairing patterns, also replacing patterns broken. This account is to cover work that is not chargeable to customers.

FLASKS.—*Account No.* 175—to include all labor and material used in repairing burned, broken or worn out wood flasks, wood flask bars, also broken iron flask parts.

DEPARTMENTAL.

STABLE.—*Account No.* 180—to include time of teamsters and those employed about stable, also feed, bedding, horseshoeing and supplies used.

PATTERN SHOP.—*Account No.* 181—to include labor and materials that cannot be charged direct to some other account, also pattern-shop supplies.

MACHINE SHOP.—*Account No.* 182—to include labor and materials that cannot be charged direct to some other account, also machine-shop supplies.

CARPENTER SHOP.—*Account No.* 183—to include labor and materials that cannot be charged direct to some other account, also carpenter-shop supplies.

BLACKSMITH SHOP.—*Account No.* 184—to include labor and materials that cannot be charged direct to some other account, also supplies used by the blacksmith shop.

POWER PLANT.—*Account No.* 185—to include time of engineer and fireman and any other labor used in the boiler and engine rooms, also coal, oils, compound, waste, tools, etc.

PATTERN STORAGE.—*Account No.* 186—to include time of those in charge of the pattern storage as well as any supplies used in same.

SHIPPING ROOM.—*Account No.* 187—to include labor in shipping room, boxes or barrels (made or purchased) with which to ship castings as well as any supplies used in same.

MISCELLANEOUS SHOP.

RIGGING.—*Account No.* 190—to comprise the rigging or special equipment made for some particular customer or work and to include time of moulders, core makers, pattern maker or carpenter or any other labor applied to this particular class of work and to also include cost of metal used, and any supplies like bolts, nuts, screws, rods, rings, etc.

TAXES.—*Account No.* 191—(*).

INSURANCE.—*Account No.* 192—(*).

DEPRECIATION.—*Account No.* 193—(*).

ANALYSIS EXPENSE.—*Account No.* 194—to include expense of operating chemical laboratory, such as salary of chemist, supplies used, etc., or the amounts paid to outside chemists for metal analysis.

* Self-explanatory.

COMMERCIAL—ADMINISTRATIVE.

OFFICERS' SALARIES.—*Account No.* 200—salaries of the executive officers of the company.

OFFICE SALARIES.—*Account No.* 201—salaries and wages paid to heads of departments, clerks and stenographers.

LEGAL EXPENSE.—*Account No.* 202—(*).

INTEREST AND DISCOUNT.—*Account No.* 203—(*).

GENERAL TRAVELING EXPENSE.—*Account No.* 204—all expense of traveling, having nothing to do with the selling of product.

TELEPHONE, TELEGRAMS AND POSTAGE.—*Account No.* 205—(*).

OFFICE EXPENSE.—*Account No.* 206—to include such items as:
Pencils, pens, stationery, forms, rubber bands, pins, ice, inks, brooms and dusters, folders and other miscellaneous office supplies.

DONATIONS AND DUES.—*Account No.* 207—to include such items as:
Subscriptions to magazines, association dues, gifts for charitable and other purposes.

COMMERCIAL—SELLING.

SALARIES OF SALESMEN.—*Account No.* 215—(*).

SALES TRAVELING EXPENSE.—*Account No.* 216—to include expenses for traveling when expended for the purpose of selling the product of the plant.

COMMISSION.—*Account No.* 217—(*).

SALES FREIGHT.—*Account No.* 218—to include prepaid freight or express charges on shipments to customers.

ALLOWANCES.—*Account No.* 219—to include credits given to customers when they do not come under the head of credits for defective material or invoice corrections.

DEFECTIVE CASTINGS—*Account No.* 220:
A—to be charged with castings returned from customers at invoice prices, less scrap value.
B—to be charged with difference between scrap and invoice values when castings are kept by customers.
C—to be charged with castings scrapped after being weighed and reported as good, at cost value less scrap value.

These various items are in reality a number of "magnets" which are ready to draw the various details to them *automatically* in such a manner as to show periodically the totals of the various accounts. It would hardly do, however, to list the various totals on an adding machine in order to arrive at the total cost for two reasons:—

1.—Because analysis is facilitated only when the item of *total cost* is divided into the groups necessary to enable the executive fully to grasp the real significance of the grand total.

2.—Because the various items vary widely in their nature. It is therefore necessary to separate the items, as shown above, into their logical controlling elements; but as the length of this article renders further elaboration out of the question, the discussion of the elements entering into production costs will be concluded in the paper to follow, which will show how the various items are grouped, how and why they are apportioned to product, etc.

* Self-explanatory.

THE LUBRICATION OF BEARINGS.

By A. L. Campbell

LUBRICANTS may roughly be classed under three heads—solids, greases, and oils. Graphite, or plumbago, is probably the most used solid lubricant. It is an amorphous form of carbon and is used in the form of a fine, flaky powder obtained by grinding. It is used extensively alone, but more commonly mixed with oil. It finds its most extensive use with very heavy pressures and slow speeds, although sometimes used alone on light machinery, such as silk looms, where oil would injure the silk.

Soapstone is occasionally used mixed with oil for heavy duty. Graphite and soapstone are sometimes employed, mixed with soap, for lubricating wood. Soapstone should, however, be used with care, since it is apt to contain more or less grit. Flowers of sulphur may be used with oil on bearings which are apt to run hot, instead of graphite. The sulphur is apt to collect in and to clog the oil channels. It is now almost entirely replaced by heavy mineral oils.

Grease is any compound of oils or oil-producing substances which is solid or semi-solid at ordinary temperatures. Grease should never be used in a bearing except where the temperature of the surrounding air is higher than the melting point of the grease. If the air is not so hot as this then work must be converted into heat in order to keep the bearing hot enough to make the grease run to it. This is a fact often overlooked in power-plant economy, and may amount to a considerable sum per year.

For example, a standard cast-iron babbited pillow block for a 3 7/16 inch shaft will have about 2 square feet of external surface. If it is lubricated by a grease which melts at 120 degrees F., and the temperature of the air is 60 degrees, find the power consumed in melting the grease.

The temperature of the bearing must be not less than 120 degrees F. in order that the grease may run and the bearing be lubricated. Then the difference in temperature of the bearing and the air surrounding it will be 60 degrees F. Text books on heating and ventilation give the radiation from cast iron to air to be about 1.5 B.t.u.

per square foot per hour per degree difference of temperature, where the source of heat is 60 degrees hotter than the air. Then the total number of B.t.u. radiated by the bearing per hour will be about 180. Since one B.t.u. is equivalent to 778 foot pounds of work, we have 140,000 foot pounds of energy per hour, equivalent to 0.071 horse power, consumed in melting this grease alone. This amount does not take into account the friction in the bearing due to the viscosity of the grease after it is melted, or other sources of friction. If a horse power is worth $75 per year, 0.071 horse power will cost $5.32, and this is the amount which may be wasted per year by using grease in a single bearing of this size. In a small plant where the engine is overloaded a horse power on the line shaft is worth much more than the above sum to the owner, and by using a good grade of lubricating oil in the bearings instead of grease, many plants would be able to install the extra machinery they need so badly, with no further load on the source of power.

Lubricating oils may be divided into two classes, viz., animal and vegetable oils on the one hand, and mineral oils on the other.

The former are all fixed oils, since the volatile and essential oils are not used for lubricating. Any attempt to volatilize them results in causing them to decompose. They contain a small amount of oxygen, and being complicated chemical compounds they are attacked by the oxygen of the air. Mineral oils being more stable are not attacked by it. The fixed oils that are most easily attacked by oxygen are the drying oils, which are of use to the painter; while it is the non-drying oils that furnish the lubricants.

Mineral oils are much more satisfactory than either animal or vegetable oils, and though they usually cost more their superior qualities outweigh the higher price. One reason for this is that oils of animal or vegetable origin contain more or less fatty matter which is apt to decompose, and form acids. These acids attack the bearing surfaces with which they come in contact, causing them to corrode and become pitted. This acid may, however, be neutralized by placing lead or zinc shavings in the oil and agitating it. The acid then combines with the metal, forming lead or zinc soap, which is easily separated from the oil. To prevent further acidity suspend a piece of either of the above metals in the oil tank. Such oils should never be used in a hot place, as in a steam cylinder. Even if the oil contains no acid when used, the heat will at once decompose it and acids will be formed.

In these days of large and high-speed engines the quality of the lubricant is of vital importance. However, it is by no means an

uncommon thing for a firm to pay a large bonus for an engine of extra high duty, and then furnish the engineer with an inferior oil for the sake of saving a few cents per gallon. The falseness of this economy is apparent when it is known that there may be a difference of as much as 5 per cent in the efficiency of the engine by using an inferior lubricant instead of a good one. Also with inferior oils the wear and tear on brasses, journals, etc., may be serious, whereas with a proper supply of good lubricant there should be no appreciable depreciation. As a general proposition it is safe to say that the best oil is by far the cheapest in the end.

Competition is now so keen that the adulteration of lubricating oils has become very common. Whenever possible the safest way to avoid trouble and loss is to have samples examined by a competent chemist, who also has the means of testing their lubricating properties.

A good lubricant should have sufficient viscosity, or body, to keep the rubbing surfaces separated (the amount of body required varying with the duty to be performed), a low coefficient of friction, and a large capacity for absorbing and dissipating heat. It must vaporize at a high temperature and solidify at a low one. It must be free from grit, or acids, or anything that would injure the bearing surfaces. It must not gum up or decompose while in use, and it should not evaporate or catch fire under the conditions of service for which it is used.

In general, that lubricant should be used whose viscosity is the least required for the duty which it has to perform. This is due to the fact that, other things being equal, the friction in a bearing is proportional to the viscosity of the lubricant. Thus power is lost by using an oil of too great viscosity for the work done.

The manner in which the lubricant is supplied to the bearings is of vital importance. One gallon of good oil properly distributed to the bearings will do more good than a barrel of the same oil not properly applied.

The following rule can be easily learned, and applied to nearly all classes of bearings:—Introduce the oil at the points of least pressure and do not provide a means of escape for it at the points of greater pressure. It is quite easy to find those points of a bearing that are least subject to pressure, and with a little scheming the oil can usually be brought there. The means of escape most often found are oil holes and channels placed just at the crown of the bearing, where the pressure (for a vertical engine) is greatest.

When the pressure on such a bearing is intermittent the oil goes

in when the pressure is taken off, and escapes again when the pressure is applied, and the bearing is able to support only a portion of the load which it could support if lubricated according to the above rule. It is almost impossible to lubricate such a bearing well if subject to a continuous load. Not a drop of oil will run down the hole at the crown of the bearing, and if oil is put in elsewhere it runs out of the hole at the crown.

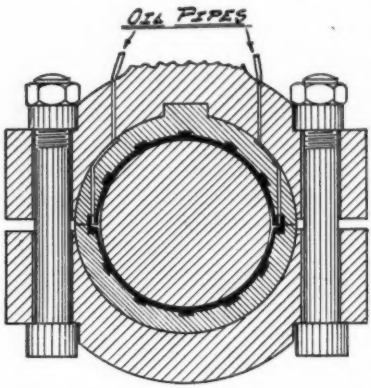


FIG. 1. LUBRICATION OF CRANK END OF CONNECTING ROD ON A VERTICAL ENGINE.

The accompanying diagrams represent the principal bearings of a vertical engine to which this rule has been applied.

Figure 1 is the crank end of the connecting rod. In this case the two sides of the bearing are the points of least pressure, and oil is led to chambers at the sides. From these chambers suitable inclined planes are provided, and the oil will arrive at the surfaces which have to bear the load at a pressure equal to the load. It will be noticed from the illustrations that the means of lubrication are in duplicate. This provides for emergencies, and in the case of large bearings is strongly recommended, as otherwise one-half of the bearing must be lubricated by the oil which has passed through the other half; and in very large bearings this is not always sufficient, especially when they are new.

Another excellent way to oil the crank pin is illustrated by Figure 2. The crank disk is grooved and a ring is fastened to it. An oil hole leads from the bottom of the groove to the surface of the crank pin, and oil that is put into the groove will be carried by centrifugal force to the crank-pin bearing

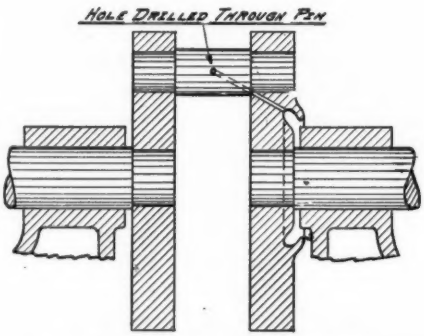


FIG. 2. LUBRICATION OF CRANK PIN.

when the parts are rotating. The drip from the inner end of the crank-shaft bearing may be thus used for the crank pin or oil can be fed directly into the groove by means of a pipe leading to the under side of the crank shaft.

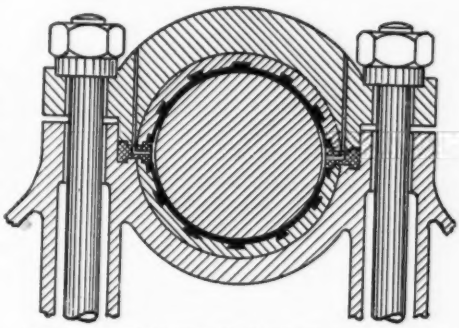


FIG. 3. LUBRICATION OF MAIN OR CRANK-SHAFT BEARINGS.

Figure 3 represents the main or crank-shaft bearings. The duty of these bearings is almost identical with that of the big end of the connecting rod. As will be seen, the method of lubrication is also the same.

It seems to be an established custom to make the under brasses of these bearings hexagonal or square, and carefully fitted to their seats. At one time it was customary to provide them with projecting faces, called chipping strips, to avoid the necessity of chipping and filing the entire outer surface. As steam pressures increased and engines grew larger this was found to be highly objectionable, since the brass was not supported at all points and deflected under the heavy percussive forces coming upon it; and the practice has become unpopular among engine builders. With improved machine tools this practice is now unnecessary because the whole surface can be machined almost as cheaply as a part of it only.

The square or hexagonal brass is open to objection for two reasons, one being that it is impossible to remove it from most engines without first lifting out the crank shaft. The other reason is that when it becomes hot it invariably changes its shape due to the varying thickness of metal, and eventually it breaks lengthwise through the crown.

The first of these evils is overcome by making the bottom brass cylindrical and of equal thickness throughout. It can then be removed by easing off the shaft from its seat and working the brass around on top. This style of brass is also easier and cheaper to machine than the others. The change of shape is also partly overcome by making the brasses circular, but even this form of brass is often found cracked through the crown. Both styles of brasses when hot expand along the inner or bearing surface. This tends to open the brass and make the bore of larger diameter, if not prevented by the

cooler outside portion, and by the bearing seat. If the bearing becomes hot suddenly the resistance to expansion causes permanent set in the metal near the shaft, so that when cool again the brass contracts and grips the shaft. Sufficient friction will then be created to heat and expand the brass again, and at that temperature the shaft will run freely in the bearing. This is why some bearings always run warm. Repeated expansion and contraction of the metal causes it to crack, just as a piece of sheet metal may be broken by bending back and forth at a given point.

This action of the brass may be prevented by securing its two edges to the bearing seat by means of an H-shaped strip, as shown in Figure 3. If the strip be accurately fitted there will be no further trouble of this kind. This device is now used on marine engines of all sizes, and on many for land use.

Figure 4 shows the cross-head pin at the little end of the connecting rod. Here again the oil must be delivered to the sides the same as at the big end. The diagram shows the oil passages drilled in the cross-head pin. At the end a swivel joint (not shown) is screwed in and connected to a telescope oiling device. Oil is also conducted from this point to the big end by means of the two pipes shown in Figure 1.

A hot bearing is usually due to improper or insufficient lubrication, or to incorrect proportions. If the oil is supplied as shown by the diagrams, heating may be due to the fact that the shaft is not round, or is not running true with the bearing, or is not smooth enough. Still another reason may be that the bearings are not properly fitted. It is no small task to surface up a bearing so that the shaft bears evenly throughout.

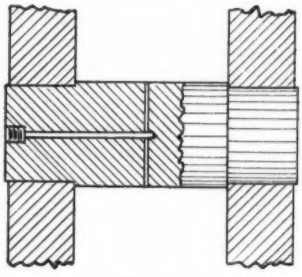


FIG. 4.

Never use emery, emery cloth, or sand paper for finishing or truing up a journal or bearing. If used the particles of emery or glass, being so hard, become imbedded in the surface of the metal and the bearing will always run hot. The best material to use is rottenstone, or powdered grindstone, mixed with a liberal amount of oil or water to "slush" out the particles of grit.

In general it may be stated that the smoother the surfaces of a bearing are the more satisfactory will be the service they will give.

It has been found that by burnishing the surface of a journal with a roller burnisher, pressed hard against it while rotating in a lathe, the friction of the bearing was lessened and more satisfactory results were secured. It is the practice of at least one of the railroads of the middle west thus to roll the journals of their car axles while turning the wheels in a lathe. However, a bearing which heats continually may sometimes be cured by draw filing the journal. In this case the longitudinal scratches on the shaft act as little pockets, or reservoirs, which carry the oil in between the surfaces and distribute it over them. The improvement in the bearing is no doubt due to more efficient lubrication alone.

To prevent injury to an oil-lubricated bearing if it runs dry through neglect or failure of the oiling device, sufficient grease to lubricate it for a reasonable period may be placed in a suitable recess formed in the bearing. As long as the lubrication is sufficient to keep the bearing cool the grease remains; but as soon as the temperature rises the grease melts, and flows to the journal.

In most cases where a bearing must perform heavy service the diameter should be made only large enough for the necessary strength and stiffness and the length is then made such that the unit bearing pressure will be sufficiently low.

The effect of the proportions of a journal may be illustrated as follows: Suppose a bearing of a given size is overloaded, and heats excessively, and must be redesigned. First, let the diameter of the journal be doubled, the length remaining as before. The total frictional resistance to rotation will be the same in both cases. The rubbing velocity is, however, twice as great as before, so the power lost in the bearing is doubled. This means that twice the amount of heat is generated in the larger bearing. The area of the surface which conducts this heat away is also doubled, so the amount of heat to be taken care of by each unit of surface is the same in both cases. Therefore, this bearing will heat as badly as the first one, and in addition twice as much power is absorbed by the second bearing.

Now let the length of the bearing be doubled and the diameter remain unchanged. The frictional resistance to rotation and the velocity of rubbing are the same as in the original bearing, so the power lost in friction, and the heat generated, is no more. But the surface carrying away the heat is twice as great, so the amount carried per unit of surface is diminished by one-half; and with these proportions the bearing ought to run cool.

So long as enough lubricant is fed to a bearing to keep the journal and box from touching almost any of the common metals could

be used. The weakness of some of these metals or the injury which is apt to occur to them if lubrication ceases bars them from use in bearings except for slow speeds and light loads. Other metals, while efficient in all other respects, have a very high coefficient of friction, and should not be used.

A bearing that is used for heavy service continuously should be made of materials which will continue to run together even though lubrication is scanty, or fails entirely for a time.

Marine engineers seem to be very generally agreed that bearings should be lined with one of the alloys known as the white metals. These alloys have a low coefficient of friction, fuse at a low temperature, and pour readily like babbitt. They do not injure the surface of the journal when lubrication fails and in case of excessive heating they melt and flow out of the box. This is a valuable property for some classes of high-speed machinery where sudden stoppage by the bearing freezing would be disastrous.

The white metals may be divided into three classes. The first contains up to 80 per cent of tin, the second up to 80 per cent of zinc, and the third up to 80 per cent of lead. If we could be sure of always using an oil containing no acids, there would be little choice between these three classes. But those who are responsible for the lining of a bearing are not always responsible for the quality of oil used in it. Lead and zinc are readily attacked by the acids of lubricating oils, while tin is affected very little by them; so the safest way is to use an alloy composed principally of tin, and containing only enough lead and zinc to impart to it other necessary qualities.

Many of the bearing metals now used are too soft for heavy duty, and yield under a load of as little as 1,000 pounds per square inch. Such a metal is liable to squeeze out of place when in use. An all-around bearing alloy should stand five times this load without any yield.

It is a very common custom to hammer or peen the alloy after a bearing has been lined. If the alloy is as hard as is usually needed it will not be very ductile, and hammering cracks it in all directions. If, on the other hand, the alloy is ductile enough to stand hammering, it is certainly too soft for lining any bearing except those whose duty is light.

NEWER ORE-TREATMENT AND METALLURGICAL PROCESSES AND THEIR MACHINERY.

By Chas. C. Christensen

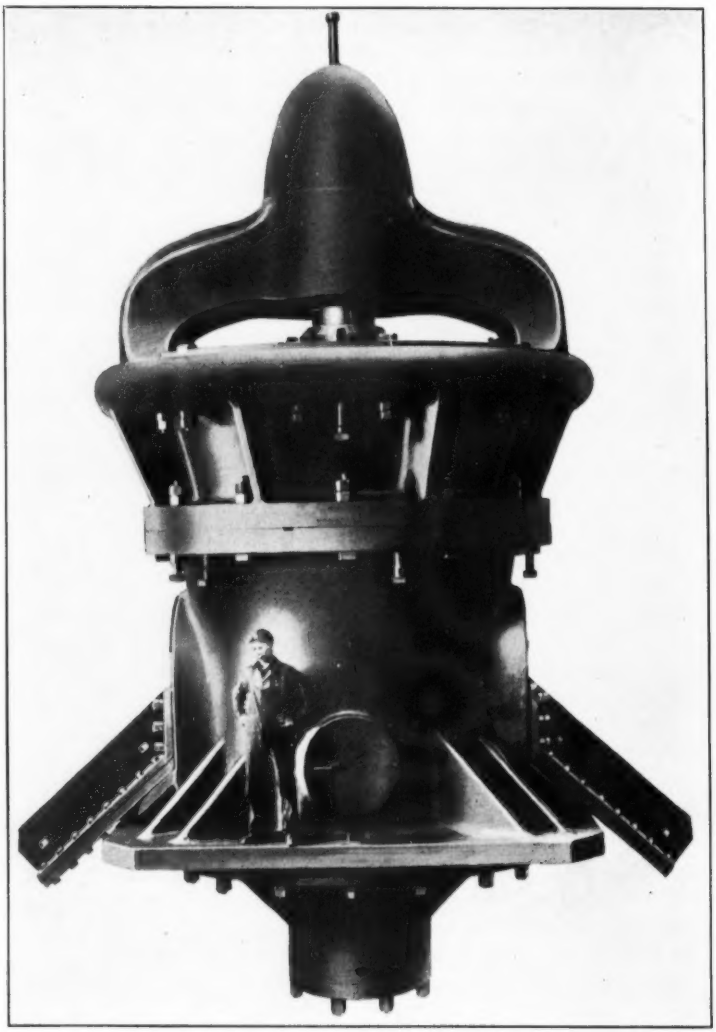
An Eificiency and Economy Number of THE ENGINEERING MAGAZINE would not be complete without some reference to the rapid progress in ore-treatment and metallurgical processes and machinery. Mr. Christensen's review deals with the latest practice in a few of the more recently developed processes, namely, the modern cyanide process, the lixiviation of oxides and carbonates of copper, the electrolytic treatment of copper sulphide ores, the Elmore vacuum process for the concentration of mixed sulphides, and, among new appliances, the electrically operated copper converter.—THE EDITORS.

ALTHOUGH the mining machinery of to-day is as perfect and prominent in design as are the new fast Cunard liners in their own element, new ideas make their appearance all the time. New processes are introduced and consequently new machinery must be designed to meet them. Mining engineers as well as mechanical engineers are kept busy—even in so-called panic times—to solve these new problems, to design and build the new plants, and to redesign and rebuild existing mills. A number of modern mining plants, each a masterpiece of engineering in itself, have been designed and built in the United States since the beginning of the century, and several more, at the time this article is written, are in course of construction in America and elsewhere.

A consideration of the changes in processes and in the machinery required may well begin with the examination of a modern cyanide plant as it should be designed today. I will assume that the predominating value of the ore is silver and that the pulp will require about 24 hours to be brought into solution. I will further assume that I can buy commercially an electric current, transform it down to the proper voltage, and distribute the power from the main switchboard to the motors in the mill, and I will distribute the motors so as to give unit drives to the several sections of the plant. I will figure on a separate crushing plant of double the capacity required, so as to run it in the daytime only, and I will assume the cyanide plant to treat about 200 tons of ore per day of 24 hours.

Following up these data the process and its machinery would be as follows:

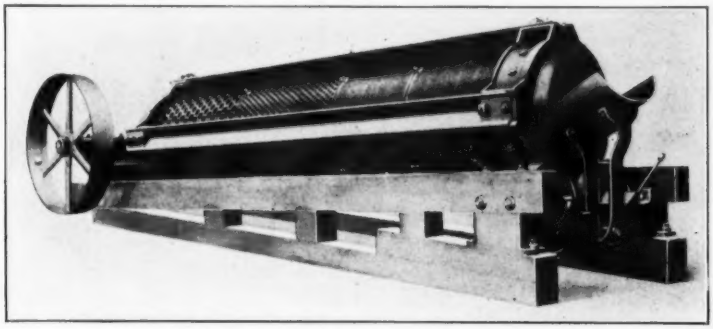
The ore is taken from the mine in cars and discharged into a large steel ore bin, located in the crusher building, and the ore is



A LARGE GATES CRUSHER.

drawn therefrom through an ore-bin gate of the counterbalanced type, into a large Gates ore breaker. This gyrating type of crusher stands to-day as the leader among ore breakers. The crusher is set to crush all the ore to pass a 2-inch ring and the product is delivered

to a continuous bucket elevator, which elevates and discharges the ore into an iron-frame revolving screen 40 inches in diameter and 12 feet long, having 1-inch perforations. This revolving screen has no shaft, spider, or other obstructions to wear out or impede the free passage of the material to the discharge openings. It runs on rollers and is driven by a pulley placed on a countershaft, having a bevel wheel fastened to the periphery of the discharge end.

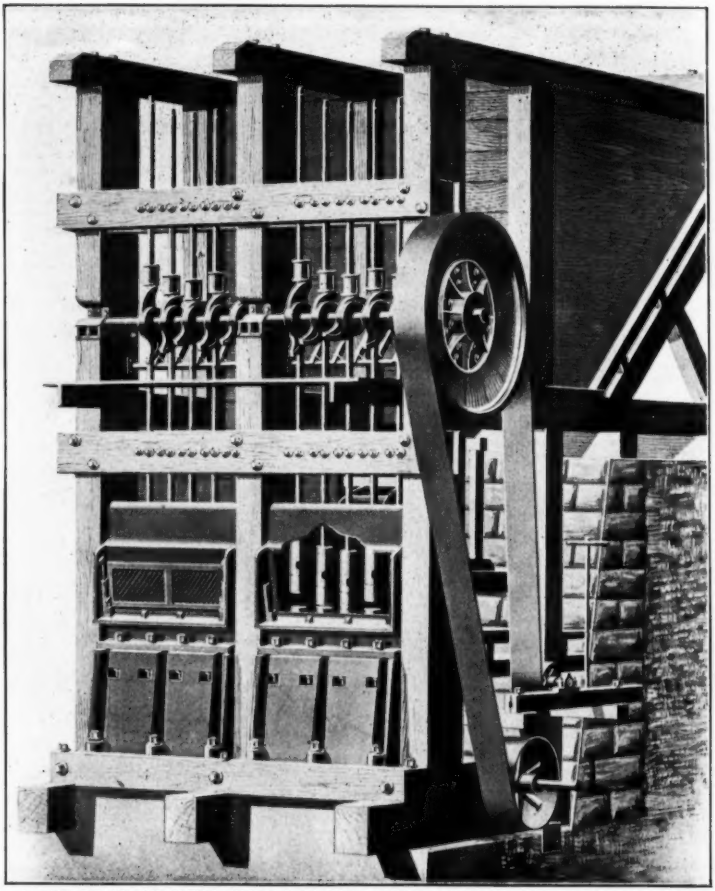


GATES IRON-FRAME REVOLVING SCREEN, LEFT-HAND DRIVE.
The Allis-Chalmers Co.

The product passing through the 1-inch holes is delivered directly to a belt conveyor and conveyed to the mill building. The rejections from the screen, or material which will not pass 1-inch perforations, is spouted into two smaller Gates crushers. These breakers, of the special short-head type for fine crushing, reduce these rejections to ¾-inch size and finer, and discharge the product direct on the same conveyor which receives the less than 1-inch material from the screen. This conveyor has a carrying belt 14 inches wide, and, if necessary, could be designed to travel up an incline of about 20 feet per 100 feet of length.

At the entrance to the mill building this belt conveyor discharges the ore on another conveyor of the same type and size, but operating in a horizontal plane. This conveyor is provided with an automatic tripper or distributor which travels along the whole length of the ore bins located behind the stamp batteries, delivering the ore automatically into the bins throughout their entire length.

At the point where the ore is discharged from the first conveyor on the second, a Cole automatic sampling device is placed to take samples of the crushed ore. This sampler is very ingenious. The arrangement is such that a sample scoop is made to pass through the ore stream and take a sample across the full width of the belt during



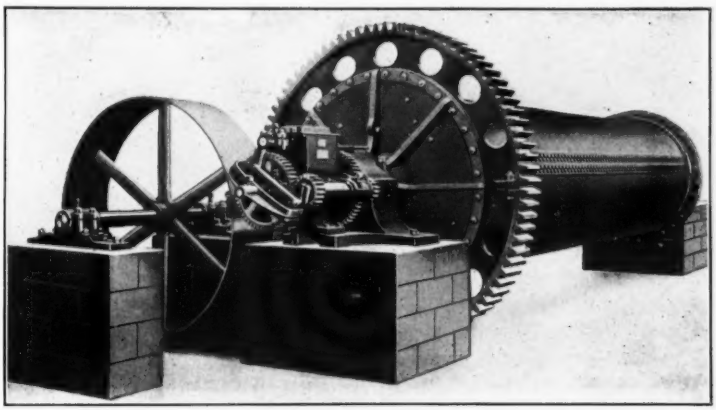
A TEN-STAMP BATTERY, CAST-IRON ANVIL BLOCK AND CONCRETE FOUNDATIONS.
The Allis-Chalmers Co.

its passage. By adjusting the driving mechanism the frequency of sampling can be arranged.

The crushed ore is drawn from the battery bins into the automatic feeders which are of the suspended or hanging type, arranged to be moved back from the mortars when necessary, giving a large working space for making repairs. There is one ore-bin gate for each five-stamp battery. Forty stamps are required, each weighing 1,050 pounds, and they are arranged in eight batteries of five stamps

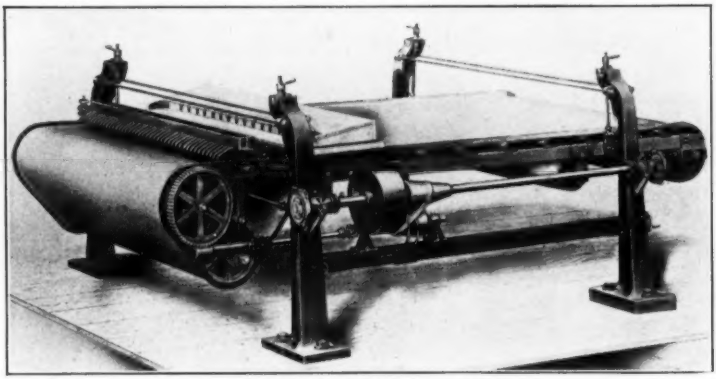
each, driven by belt with tightener from the line shaft. The batteries are made right- and left-hand, set in three post frames. The mortars, one for each five stamps, are of the narrow, rapid-crushing, quick-discharge type, provided with 12-mesh screens, and the principal battery parts are made of steel to insure maximum wearing life. The pulp from each five-stamp battery is delivered to a 24-inch sizer or cone classifier, which makes two products. The spigot or coarse product of each is spouted to a Wilfley concentrating table and the overflow from each cone is delivered to two Dorr classifiers. The tailings from the eight Wilfley concentrators—one for each five stamps—are also forwarded to the Dorr classifiers by belt and bucket elevators. In the Dorr classifiers the sand and the slimes are mechanically separated.

All the pulp is crushed to 150-mesh and finer in the tube mills. The Dorr classifiers separate that part of the pulp which is already crushed to this size and it is delivered to the thickening cones for concentration on vanners as will be described hereafter. The coarse sand product from the Dorr classifiers is discharged into two trunnion-style wet-grinding spur-gear-driven tube mills. These mills are arranged with silex flint-brick linings 4 inches thick, and the initial charge of pebble stones for each mill is 10 tons. The sands are all ground to 150-mesh or finer in these mills, each discharging its product into a classifying cone 4 feet in diameter. These cones are arranged for the purpose of separating from the product any sands which might have passed through the mills without being reground fine enough, and these sands are elevated back to the Dorr



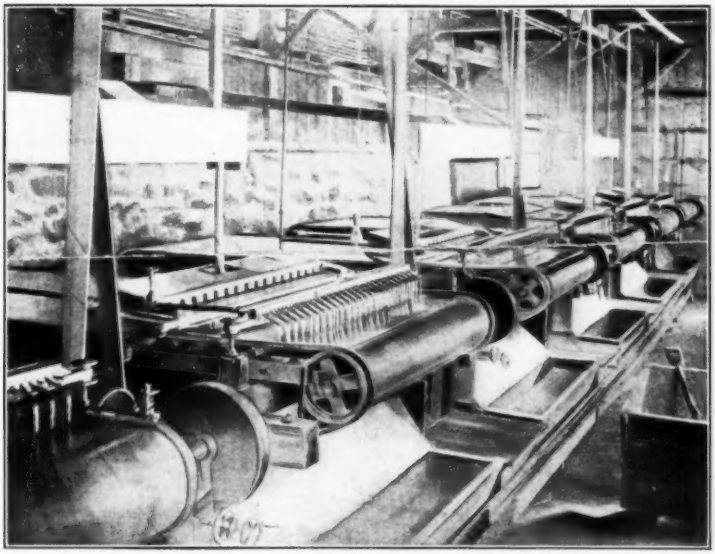
GATES TUBE MILL.
The Allis-Chalmers Co., Milwaukee.

classifiers to be fed again to the tube mills. The finished product is delivered to spiral sand pumps by which it is elevated to two large pulp-thickening or settling cones, where any excess of water is removed and forwarded to the cyanide plant. The thickening pulp from the bottom discharge is conveyed to Frue vanning machines or concentrators. This type of concentrator has an endless rubber belt supported by rollers so as to form a plane inclined rubber surface, bounded on the sides by rubber flanges. The belt travels up the incline and round a lower drum, which dips into a water tank in which the mineral is collected. In addition to the travel of the belt the latter receives a steady shaking or setting motion from a crank shaft along one side, the shake being at right angles to the inclination and travel of the belt. The pulp is fed on the belt about three feet from the head, and flows slowly down the incline subjected to the steady shaking motion, which deposits the mineral on the belt. At the head of the belt is placed a row of water jets which wash back the lighter sand, allowing only the heavy mineral to pass and become deposited in the water tank below, as already mentioned. The Frue vanners remove and collect any mineral particles in addition to what is saved by the Wilfley tables. This concentrated product is collected and dried, after which it is shipped to the smelter.



SUSPENDED IRON FRAME FRUE VANNER.
The Allis-Chalmers Co.

The tailings from the vanners and the overflow from the settling cones are delivered to any one of three de-watering tanks in the cyanide plant. These tanks are provided with filters through which the water is drawn off and flows to a final settling box, to collect any slimes carried in suspension, after which it is delivered to a water sump tank to be pumped back to the mill and used over again.

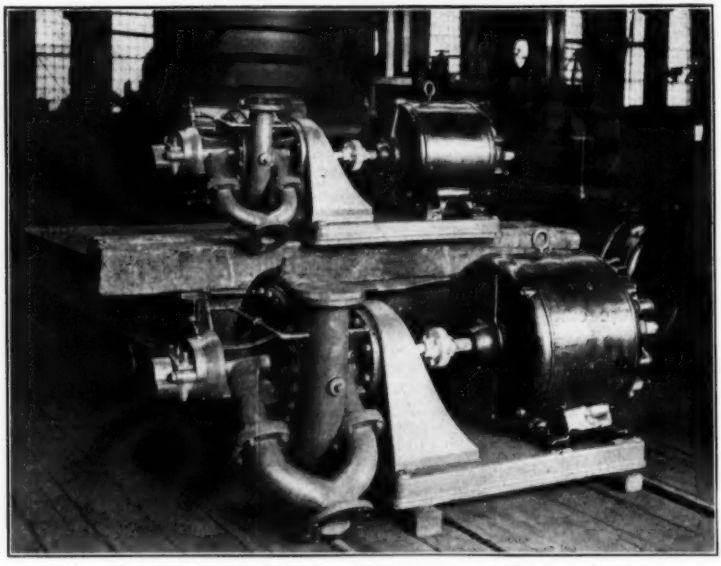


ROW OF FRUE VANNERS IN CONCENTRATOR ROOM OF A MODERN MILL.

The thickened and de-watered pulp from the settling tanks is drawn off from the bottom discharge through a pipe line connected to the suction of a centrifugal pump. This pipe line is arranged so that the contents of any tank can be drawn off, and a cyanide-solution pipe is connected to each tank to introduce solution if desired. The pulp is discharged by the pump into the agitator tanks, which are of the Hendryx type designed for rapid extraction of gold and silver by means of agitation in weak chemical solutions containing a small percentage of cyanide. The mechanical feature of this agitator is a cylindrical steel tank with a deep conical bottom. In the center of the tank is a large pipe which extends nearly to the top and the bottom, being supported by braces from the tank sides and having a circular wide flange at the top which slopes gradually toward the wall of the tank and permits the ore-pulp solution, in flowing over it, to be spread out into a thin umbrella-shaped sheet and to absorb an abundance of free oxygen. In this center pipe is a hollow shaft to which is keyed a driving pulley, near the top, and a number of pulp-solution-lifting screw propellers. A coil of pipe raises the temperature of the charge by means of hot water or steam. The revolutions of the propellers in the large pipe produce a strong upward current, resulting in a rapid and complete circulation of the

pulp upward to the umbrella flange, where it spreads out, looses its velocity, and falls gently from the edge of the flange into the mass of ore-pulp solution, where its velocity is further reduced, and then it drops gently down to the bottom of the agitator tank.

As already mentioned I have assumed the predominating value of the ore to be silver, requiring about 24 hours to be brought into solution; therefore I will figure on six 17-feet diameter agitators. After the required period of agitation, the pulp is drawn from these tanks by a centrifugal pump and delivered into the pulp-storage tank. In this tank the pulp is kept in gentle agitation and prevented from settling by a stirring gear, and from this tank the charges are drawn into the filter tanks as required.

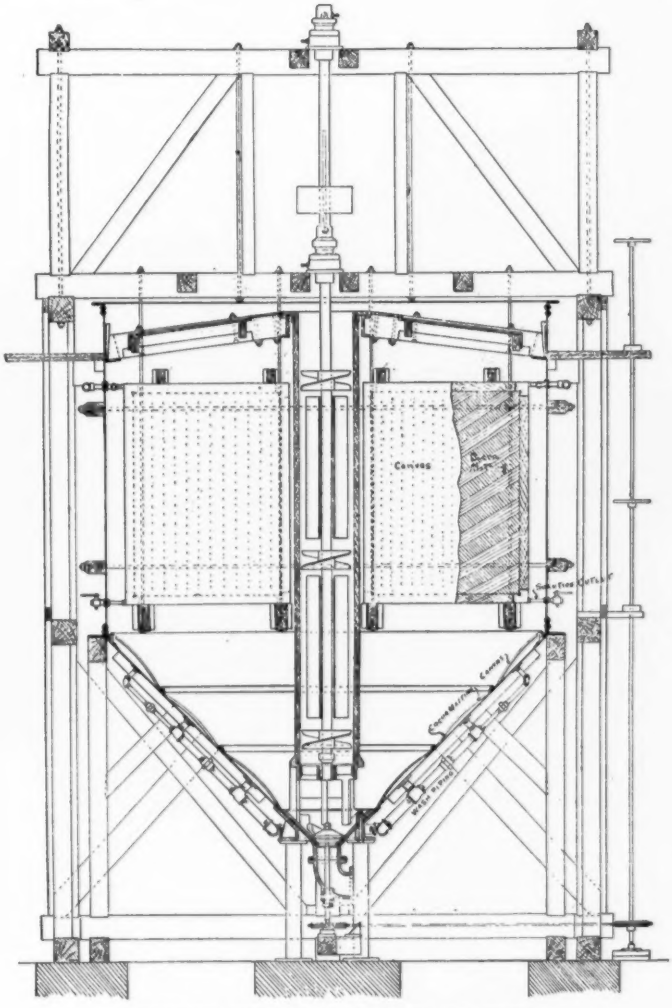


SINGLE-STAGE ELECTRICALLY DRIVEN CENTRIFUGAL MINE PUMP.

Capacity of 3-inch size, 250 gallons per minute; of 5-inch size, 800 gallons per minute. Allis-Chalmers Co.

For removing the solution from the pulp the Butters vacuum filter system is used. It consists of two filter boxes each containing 72 filter leaves. A charge of pulp is delivered to the filter box, and after removing the solution by a vacuum applied to the filter leaves, and following up with the necessary washes, the pulp is finally discharged through the bottom from the filter leaves and is sluiced out to waste. The solution is collected in a small storage tank and from

there is pumped through a clarifying filter press into any one of three precipitating tanks.



HENDRYX COMBINATION AGITATOR AND FILTER.

By means of zinc dust introduced in the form of an emulsion, and with agitation by compressed air, precipitation is effected. The contents of the precipitating tanks are pumped up to the refining plant and

A LARGE OPEN-AIR CYANIDE PLANT IN SOUTH AFRICA.
The Simmer and Jack cyanide plant.

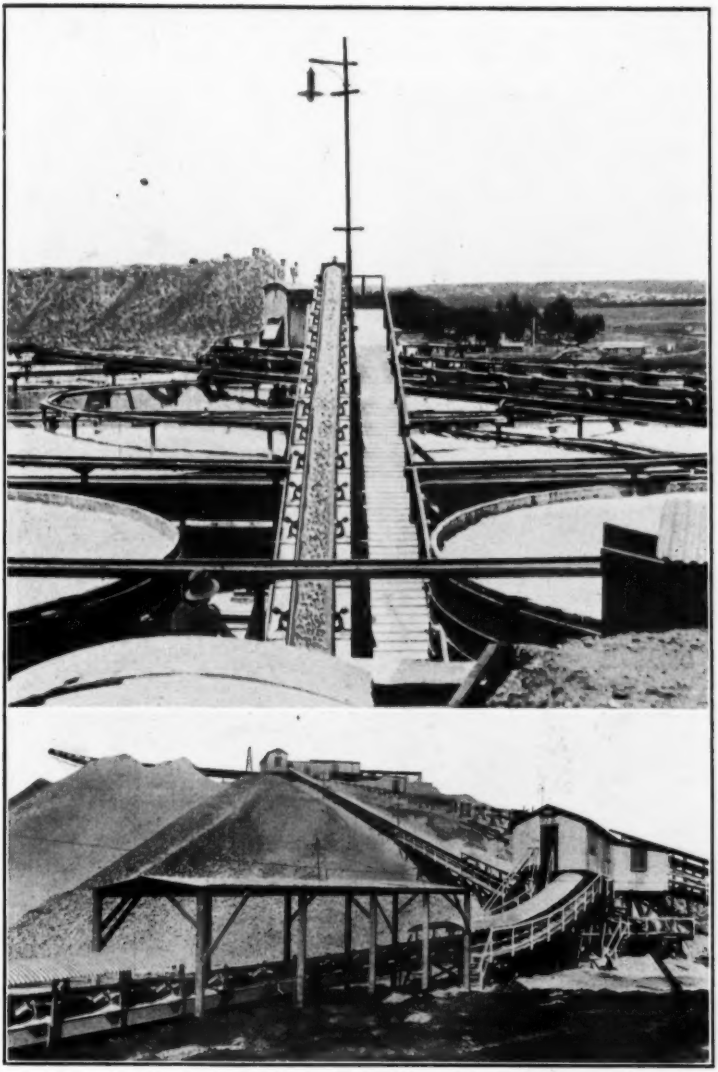
the precipitates are collected in the filter presses, through which the material passes. The solution is delivered to the storage tanks for restandardizing and used over again. The precipitates are dried and shipped to the refineries for reduction to bullion. The loss of cyanide of potassium is about 4½ pounds per ton of ore treated.

All elevators and pumps for handling water solution and slimes, for such a mill as described above, should be installed in duplicate to insure against stopping of the entire plant in case of repairs.

For a cyanide plant treating ores where gold is the predominating value the number of tanks and agitators will be reduced according to the time used for bringing the pulp into solution, and loss of cyanide of potassium in pounds per ton of ore treated will be proportionally lower.

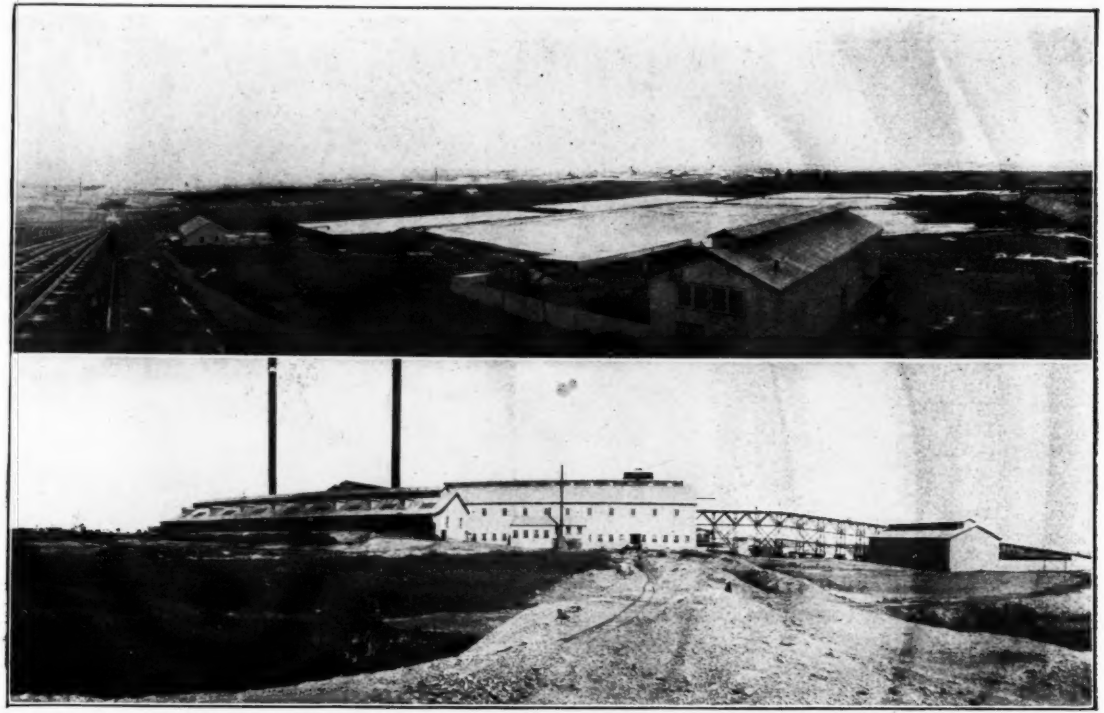
Treatment of Oxides and Carbonates of Copper by the Leaching Process.

Ore of this character, is first ground to about 20-mesh, and run into the Hendryx agitator in the proportion of two tons of water to one ton of ore, the percentage of copper present having been previously determined. Sulphuric acid is then added in pro-



CONVEYING MACHINERY, JOINT CYANIDE PLANT OF KNIGHT'S DEEP, LTD., AND SIMMER AND JACK EAST, LTD.

Four 20-inch distributing conveyors over treatment tanks and four 20-inch refuse conveyors under, each 426 ft. long. Refuse is delivered to 30-inch conveyor 310 ft. long rising 20 ft. to foot of dumps as shown in the lower view, foreground. Thence a 30-inch conveyor 430 ft. long with a rise of 100 ft. more delivers the refuse to a 36-inch distributing conveyor. Ultimately a plateau ⅛ mile in diameter will be there built. Jeffrey Manufacturing Co., Columbus, Ohio.



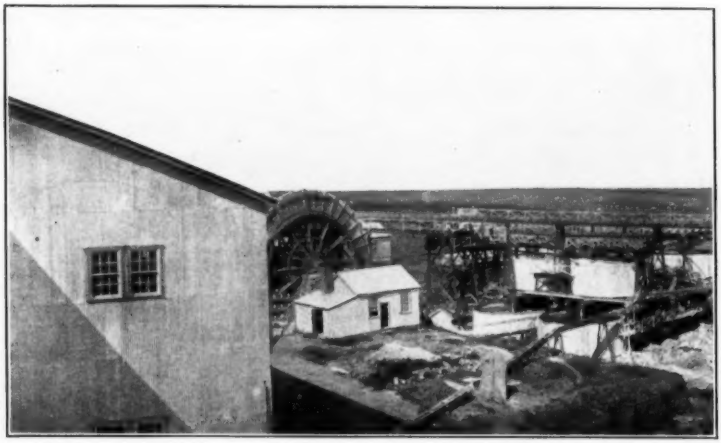
VIEWS OF THE DREIFONTAIN AND ANGELO MINES, EAST RAND PROPRIETARY MINES COMPANY, EAST RAND, SOUTH AFRICA.
The upper view shows the slimes settling pond and the store house; the lower, the 220-stamp mill.

portion to the amount of copper present. The contents of the agitator are then heated by either steam or hot water, run through a coil of pipe, to hasten the dissolving of the copper. The charge is agitated continuously for a period of one and one-half to two hours, which is usually enough to dissolve all the soluble copper. Then the charge is allowed to settle, when 50 per cent or more of the copper sulphate solution is decanted off and run to the Hendryx copper precipitator.

INTERIOR OF DREIFONTAIN AND ANGELO 220-STAMP BATTERY.
East Rand Proprietary Mines.

Sulphite solution, barren of copper, is then discharged into the agitator to replace the decanted solution, and the contents, by agitation, are thoroughly mixed in a few minutes. The charge is then allowed to settle again when the clear solution is decanted in the same manner as above. The operations are repeated until the solution is recovered to a very high percentage. On the average ore, 96 to 98 per cent of the copper solution is recovered by means of three additions of wash water.

The copper sulphate solutions and wash waters are run to the copper precipitator, where the copper is precipitated by means of scrap iron and recovered as cement copper.

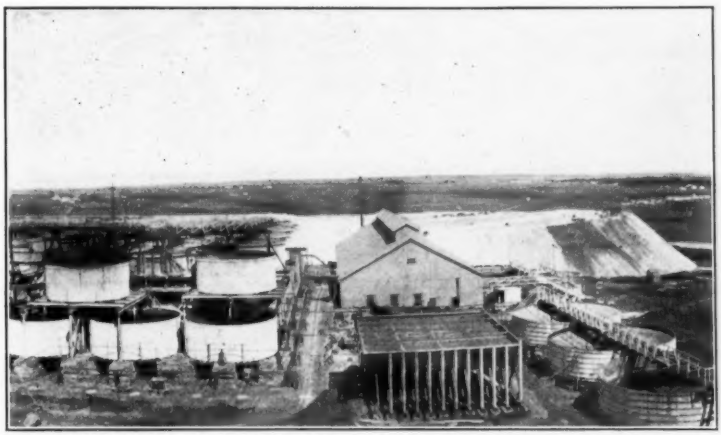


EAST RAND PROPRIETARY MINES, SOUTH AFRICA. PARTIAL VIEW, COMPLETED OPPOSITE.
Cyanide plant, Dreifontain and Angelo battery.

The precipitator consists of a cylinder with perforated heads at both ends and partly filled with scrap iron. The solutions enter at one end and leave at the other end. The cylinder is placed on rollers so that it can be rotated at a slow speed while the solutions pass through it. As soon as the copper solutions enter the cylinder, the copper is precipitated on the scrap iron and the revolving motion of the cylinder causes the scrap iron to roll and tumble, which liberates the copper from the iron. As soon as the copper is liberated from the iron it passes off with the solution to a settling tank and is there recovered as cement copper. The solution, barren of its copper, is returned to a storage tank to be re-used for washing purposes. The solutions are kept in contact with the scrap iron for such a short period of time that the consumption of iron only amounts to about one pound for every pound of copper recovered.

Treatment of Copper Sulphide Ores by Electrolysis.

The ore after it is ground to the desired fineness, is delivered to the copper agitator, which, for this class of ore, is equipped with electrolytic plates of an insoluble material. Agitation and heat are applied, sulphuric acid is added, and an electric current turned on. The iron in the ore is converted into a ferric salt which dissolves the copper. The copper is caught on the cathodes; the iron is oxidized and regenerated as a ferric salt. As soon as the copper in the ore is dissolved, the agitator is emptied, the solution filtered, the tails washed, and the wash water run with solutions previously filtered.



COMPLETION OF PANORAMIC VIEW, EAST RAND PROPRIETARY MINES.

Tailings dump, extractor house, and Comet mill in background.

Thereafter the solutions are passed through electrolytic depositing boxes and returned to the supply tank to be used for the next charge of ore. The copper is stripped from the plates in the agitator from time to time, as well as from the plates in the precipitating boxes. The copper recovered is usually above 99 per cent fine.

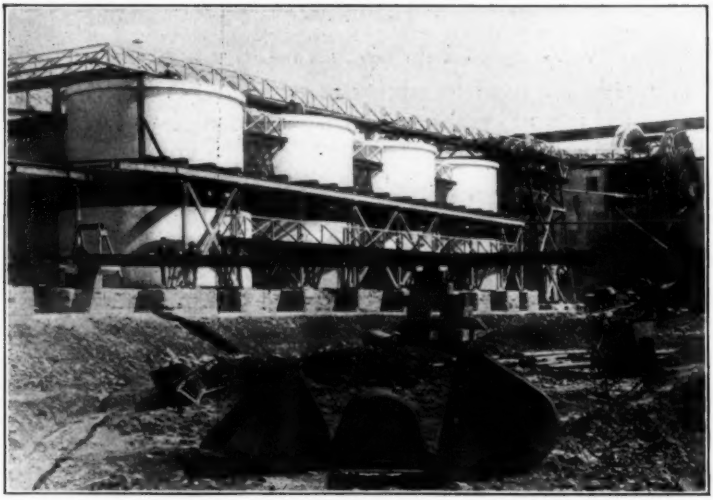
The Elmore Oil Process or Vacuum-Flotation Process for Concentration.

This new process is coming into prominence abroad. It is called after its inventor, F. E. Elmore, and is based upon the fact that, in a flowing pulp of water and pulverized ore, oil has a selective action for the mineral particles as distinct from the gangue or rocky substances. This selective power is much increased by the presence of an acid, and depends also upon the fact that the gases dissolved in water are liberated upon subjecting them to a pressure less than that of the atmosphere. These liberated gases may be increased by introduction from an external source or by generation of gases in the pulp. They attach themselves to the oiled mineral particles, and being largely increased in volume as a result of vacuum applied, cause the oiled mineral particles with bubbles of gas to float to the surface of the solution.

The machinery needed for this process is as follows:

The pulp from the crushing plant is discharged into a mixer—a horizontally placed cylindrical tank—into which is also introduced a small quantity of oil and of acid if needed. The agitation is per-

formed by a number of stirring bars keyed on and rotating with the shaft extending through the cylinder. The agitated pulp flows continuously from the mixer into a funnel and by applied vacuum is lifted up through a pipe about 30 feet above the mixer to a conical separating vessel or pan, which it fills. Near the top of the cone is a launder with an outlet pipe extending down below the mixer flow. The rate of flow of the pulp down this pipe is slightly less than the in-flow up the feed pipe; a small amount of the liquid overflows the edge of the launder carrying with it the concentrates down through the outlet pipe into a water-locked settling tank. At the bottom of the cone is a double-armed rake slowly rotated by means of a worm gear, and the blades of this rake are placed at an angle sufficient to cause the solid matter in the pulp to travel from the center to the periphery of the cone, whence the tailings continuously escape through a pipe in the cone bottom.



PART OF THE DREIFONTAIN AND ANGELO CYANIDE PLANT.

The feed pipe is about 30 feet long, the concentrates and tailings pipes a few feet longer, making the feed pipe and the tailings pipe form the short and the long leg of a syphon; whereby the power required to elevate the pulp into the cone is supplied by the falling column of pulp in the tailings pipe. So long as a steady flow of pulp is supplied to the mixing cylinder, a steady and perfect automatic discharge of tailings and concentrates is secured. In the top part of the cone are several thick glass windows, through which the

discharge of the concentrates over the lip of the launder may be observed.

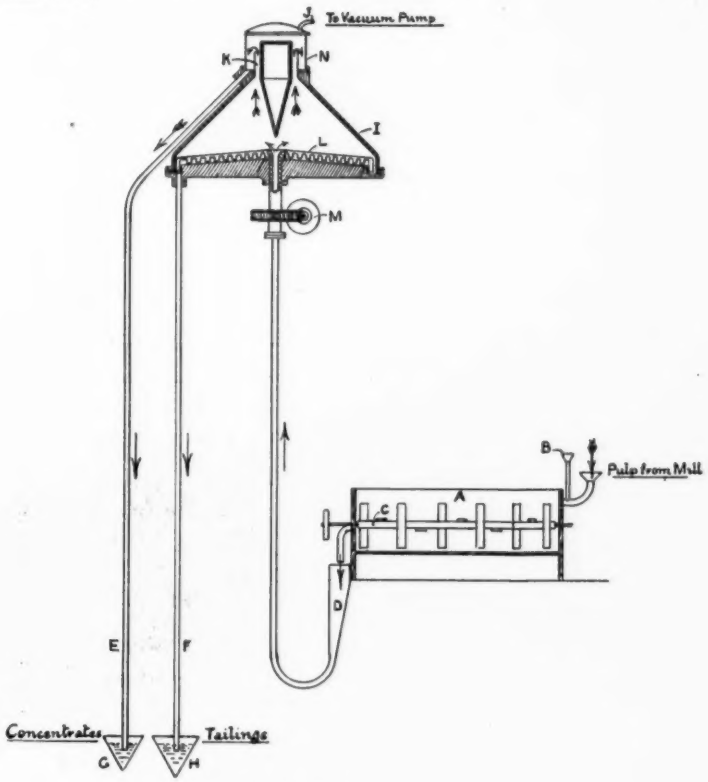
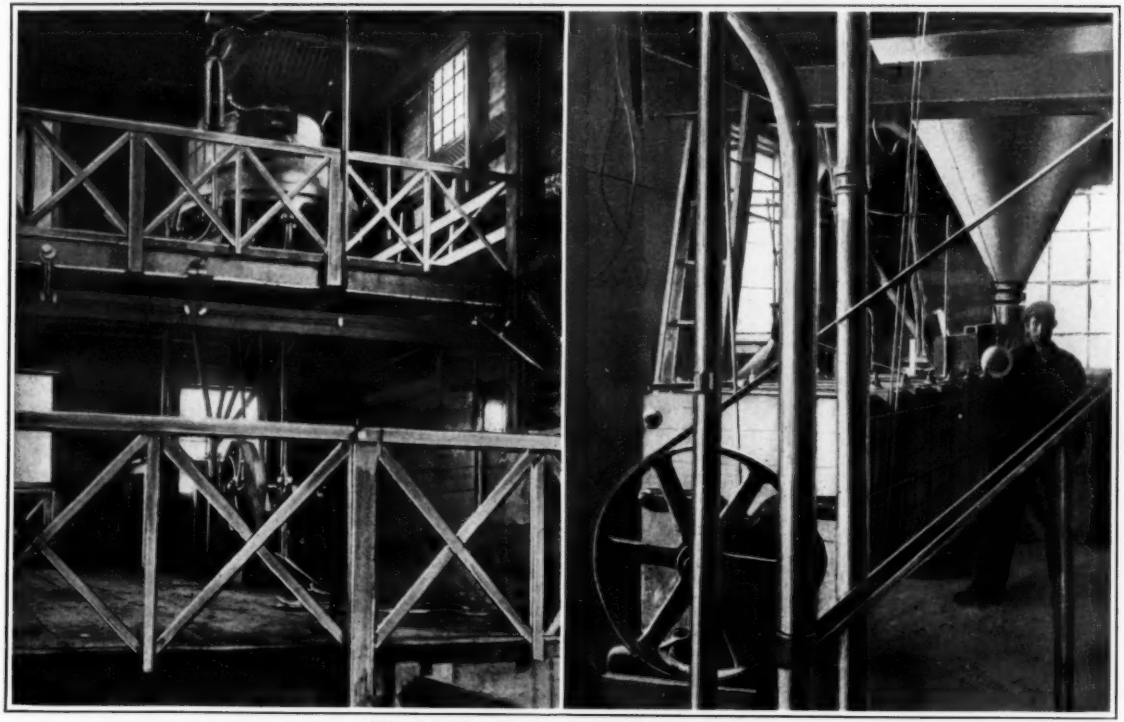


DIAGRAM OF ELMORE VACUUM CONCENTRATOR.

Ore Concentration Co., Ltd., London.

The mixing cylinder is about 2 feet in diameter, and the cone 5 feet in diameter at the bottom. The power required to run the mixer, separator, and vacuum pump, does not exceed 2½ horse power. The capacity varies with character of the ore to be treated, and the fineness to which it has been ground, running from 35 to 45 tons of crude ore per 24 hours.

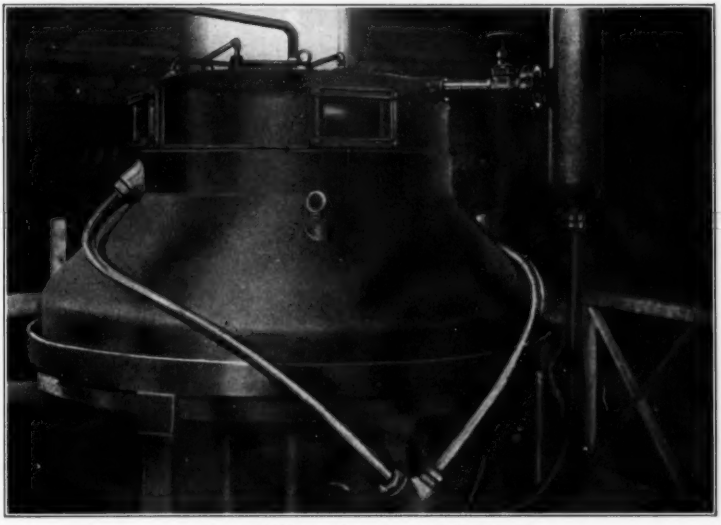
The quantity of oil and acid runs 3 to 10 pounds per ton of ore treated. Almost all kinds of oil are suitable—California and Texas crude oil, Texas residuum, Russian crude oil, fuel oil, Sumatra and



THE ELMORE VACUUM PROCESS AT DOLCOATH.

On the left, vacuum apparatus, with air pump below. On the right, mixer and settling tank.

Borneo cheap oils, blast furnace oils, olive-oil residues, oleic acid, fish oil, kerosene, etc.

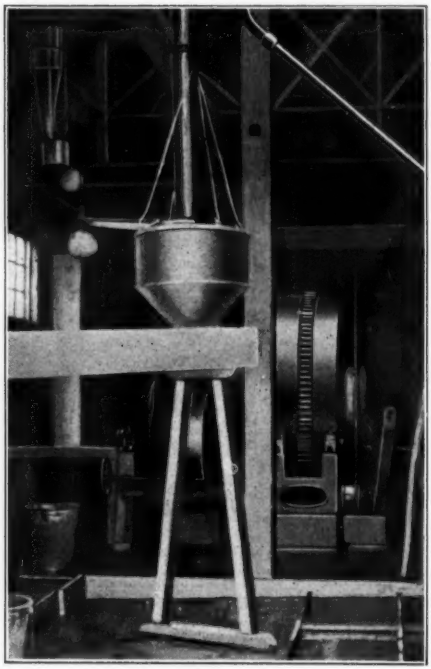


THE ELMORE VACUUM CONCENTRATOR.
Capacity 35 to 45 tons per 24 hours.

The process has been applied successfully to the concentration of ores which could not be concentrated by the usual methods. For example, galena and zinc blende are readily separated from a gangue of baryta, chalcopyrite from magnetite and spathic iron gangues, and copper sulphides from oxide of tin, leaving the tin in the tailings to be separated by the usual processes. Copper, zinc, and lead minerals are separated from garnets and other heavy gangues. Cinnabar and iron pyrites, carrying gold, are easily concentrated, yielding a high-grade product with clean tailings.

The Electrically Operated Copper Converter.

The newer converter plants have adopted the electrically operated copper converter. The evolution of machinery for converting copper matte into blister copper has consisted of a progressive series of improvements, due mostly to the many practical experiments made by the operators at the many plants throughout the mining world. By combining the latest ideas that have given the best results, and eliminating defects, it has been possible to create a converter which has many advantages over those used heretofore. In this new converter the bottom half is 84 inches in diameter, and from the center up to the



TAILINGS VALVE AND BALL MILL, THE ELMORE VACUUM PROCESS.

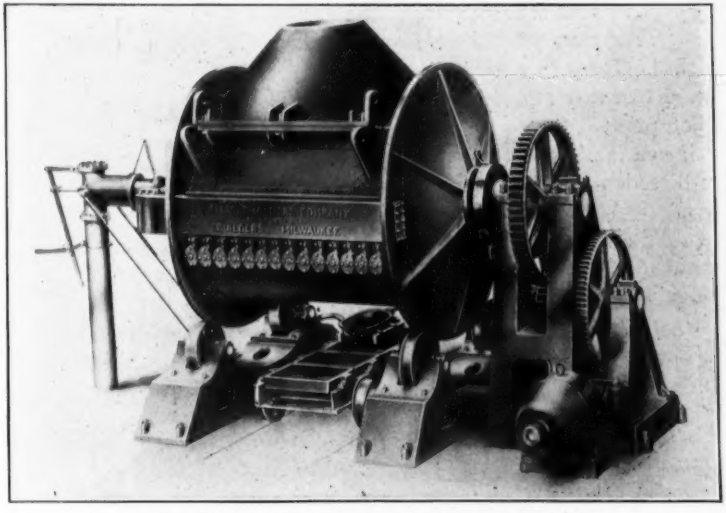
joint both sides of the shell are formed in a tangent to a width at the top of about 80 inches. The object of this is to do away with the unnecessary curvature above the center line to permit of a more secure lining being formed in the converter.

The parting joint between the bottom half and the top half of the shell is considerably higher than in former designs, the idea being to keep it as high as possible and away from the extreme action of the molten copper. The bottom section of the shell is made of flange steel 126 inches long, rigidly attached at both ends to solid cast-steel heads with riding rings cast on. The heads are spherical in shape and reinforced with heavy ribs to reduce expansion and contraction resulting from the intense heat. At the joints on the lower half of the shell are riveted on cast steel reinforcing plates provided with four lugs for lifting the shell. These reinforcing plates are also arranged for bolting on the top half by extra heavy bolts on each side.

The wind box is rectangular in shape, and consists of a plain casting which is placed close to the shell and underneath the riding rings, thereby permitting the shell to make a complete revolution, doing away with the stop placed on the riding rings to protect the wind box and prevent the shell from turning too far. This changed location of the wind box is a great improvement, because with the old stop arrangement it was necessary to be very careful in turning; otherwise the operator would throw the shell off the stand, thus causing a serious accident.

The individual tuyeres are another noteworthy improvement.

There are fourteen Repath individual tuyeres, each provided with a Dyblie ball valve. Each tuyere is secured to the wind box by swing bolts and the discharge end, which is at right angles to the inlet, projects several inches inside the shell, and is secured to the shell through a cast-steel stuffing box. This stuffing box is bored out to suit the projection on each tuyere, and is arranged for holding asbestos packing. Each tuyere is arranged so that the ball valve and its seat are self-contained and the valve can be taken out and rapidly replaced. On the air end of the shell the cast-steel head is arranged to receive the end of the wind box, which is provided with a ball-joint concave flange, and receives the stationary air nipple at the patented blast connection.



ELECTRICALLY DRIVEN COPPER CONVERTER, MODERN TYPE.

The converter is 84 by 126 inches. The Allis-Chalmers Co.

For turning the shell the stand is provided with a 30 horse power direct-current, variable-speed, multipolar, enclosed-type, series-wound motor for 110 volts and 600 revolutions per minute, which is geared up to the main drive shaft so that the maximum speed of the shell is reduced to 1½ revolutions per minute. In plants where alternating current is available, induction motors are of course used.

A sheet-steel housing covers all the driving gears and the motor complete. The capacity of the new converter is about 780,000 pounds of copper per month. Its size is 84 by 126 inches.

SYSTEMS OF WAGES AND THEIR INFLUENCE ON EFFICIENCY.

By Carl Bender.

In the following article, both the graphic method of presentation and the clean-cut definition afforded by comparison combine to show the nature, effect, and limits of the best-known wage systems. The article will be valuable as a standard of reference to all students of shop efficiency as affected by the mode of payment for work.—THE EDITORS.

THERE are two parties primarily concerned in wages—(1), The man who receives them; (2), The man who pays them.

The man who receives wages desires that they be as high as possible. The man who pays wages desires, not so much that they be low, as that they afford the largest margin of profit between cost and selling price.

Reconciliation of the two interests, if at all possible, must lie in the direction of relatively high wages and relatively low unit costs. By relatively high wages is meant an earning power above the average of the class or trade in the locality. By relatively low costs is meant costs below the average of competitors. In so far as any system of wages does not attain both ends, it is defective.

Furthermore, that condition is best which secures to the workers the largest aggregate amount of wages; one hundred dollars per month as a total to two men is better than sixty dollars to one man, the other one being idle.

Workers concede that rates for different kinds of work may vary, but would prefer that all men working in the same grade receive the same rate irrespective of efficiency. The wage payer is generally willing to pay a higher rate for a higher efficiency. The rate of wages however is constantly fluctuating, sometimes rising, sometimes falling, even for the same work in the same trade, and rates of wages as well as earning power fluctuate as to the same man. Sometimes he is employed, sometimes not; sometimes he is in one part of the country, sometimes in another; he may for a time be promoted to a foremanship and then drop back again. The extreme variation for unskilled day laborers within the territory of the United States runs from $0.50 per day in parts of the South, to $15.00 per day, at certain gold camps in Alaska.

An improved system of wages is one which will fulfill the following conditions:

1.—A guaranteed rate per hour for each grade for a contract period.

2.—An average earning power continuously higher than usual.

3.—A progressively lower cost to the wage payer, as wages automatically increase.

4.—A supplemental earning power to the worker above day rate, the supplement being based on the efficiency of the worker.

Whether such a system is attainable or not, various systems of paying wages will be enumerated and discussed with reference to these requirements.

All facts as to wages can be put into very simple diagrams. Such diagrams can be made to show:

1.—The rate per hour to the worker.

2.—The total cost per hour to the wage payer.

3.—The rate per piece to the worker.

4.—The cost per piece to the wage payer.

In this study, only diagrams as to rate per hour will be used.

Costs may be divided into wage costs and all other factory costs. Other factory costs can be subdivided into (a), machine rates, and (b), all other overhead charges, generally assessed at so much per productive hour or at so much per dollar of productive wages; it makes little difference which.

Both machine rates and overhead charges increase as hours are shortened, whether owing to shorter days or fewer men. Even if a plant is wholly shut down, such heavy items of expense as insurance, taxes, depreciation and interest on investment remain. Except incidentally, overhead charges will not be drawn into this analysis of systems of paying wages.

In the day-wage diagram shown on the next page, it is assumed that a job should be done in seven hours and that it should therefore cost $1.75 for wages.

Wages and wage cost are in exact proportion to the time the worker is present. If the worker can be driven harder, he earns no more per hour, but his work costs less. If he takes it easy he earns no less per hour, but his work costs more. Day wages were merely a step in advance of slave labor—existed side-by-side with slave labor—and both were based on the supposition that an overseer should stimulate activity much as a driver by various encouragements, abuse included, stimulates a horse. The great objections of the wage payer to this system are; first, that it requires an overseer, one man to do the

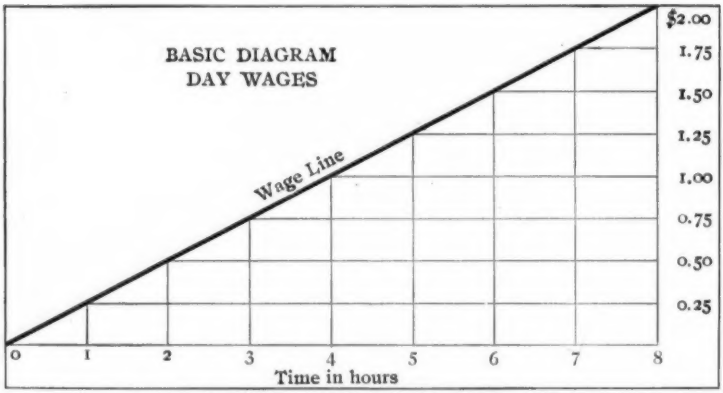


FIG. 1. DIAGRAM OF WAGES UNDER DAY-PAY SYSTEM.

work and another to force him to do it; and second, that he (the wage payer) never knows what the work will cost him for wages.

The usual objection to it, from the wage-earner's point of view, is that it puts the best man on the same level as the worst. A worker does not earn in proportion to his efficiency. The results are:

1.—That the more enterprising men are out of sympathy with their surroundings and are lost to the class that most needs them, become strike breakers, etc.

2.—That many men resort to trickery and treachery for advancement rather than to efficiency. They increase their pay by accepting bribes or stipends to spy upon their fellows.

Piece Rates.

Piece rates were hailed as a great discovery. The wage payer sees in them the means to accomplish for himself several desirable results.

1.—He unloads on the worker the responsibility for everything that goes wrong. This is both unjust to the worker and deleterious to the payer, as it is the payer's, not the wage earner's, business to ameliorate general conditions.

2.—He establishes a fixed cost per piece, which is at least convenient. Moreover, he is temporarily spared any worry over the fact that the cost is not as low as it should be.

3.—The worker who does not deliver the tally is punished by being paid less.

4.—Efficient workers are rewarded by higher earnings, (until their piece rates can be "trimmed").

Piece rate has not proved satisfactory because it rests on a fundamental fallacy—namely, that permanently just rates can be predetermined. Conditions are constantly changing. These changes must be met by a change in rate, either up or down. If a rate proves too low, the worker at once clamors for an increase, and if he can make out a case, obtains it. If it is too high, he makes no complaint, but nurses the soft snap. To correct the rates that seem to him too high, the payer waits for a favorable opportunity and reduces horizontally all the piece rates. Every action of this kind arrays worker against payer. Reason and justice are shoved to one side; brutal ability to further his own advantage, whether by worker or payer, is substituted.

It stands to reason that when the invention of high-speed steel and the building of new wheel lathes reduce the time of turning tires from eighteen hours to one hour, the same piece rate per pair of tires cannot stand, especially as the worker contributed nothing towards the reduction; but, on the other hand, managers have so little understood the delicacy of the piece-rate problem that they have ordered piece rates to be installed on three-days notice, trying to adopt, wholesale, rates not only from other shops in a different part of the country, but initially inaccurate. To establish piece rates in this manner is to sow the wind and reap the whirlwind.

Moreover, the only way a man in the office judges of the correctness of a piece rate is by the earnings of the worker, and fair rates to extremely efficient men are trimmed impartially with too easy rates to inefficient men. A worker, made wise by experience, attempts to protect his rates by limiting his output; so that usually the moral state of a piece-rate shop is decidedly more unfavorable than that of a day-rate shop, both as to employer and employee.

The diagram shows that if the worker fails to do the job in six hours, he earns less than $0.25 per hour; if on the other hand he does the job in three hours, he earns $0.50 an hour. Piece rates share with day rates the advantage of permitting the worker easily to calculate and keep tab on his own earnings.

Systems that are more complicated leave often in the mind of the worker the impression that his wages are being juggled and that he is probably being tricked out of what is justly due him.

Halsey Premium Plan.

To mitigate to some extent the evil workings of piece rates Mr. F. Halsey invented the premium plan shown in diagram on the next page.

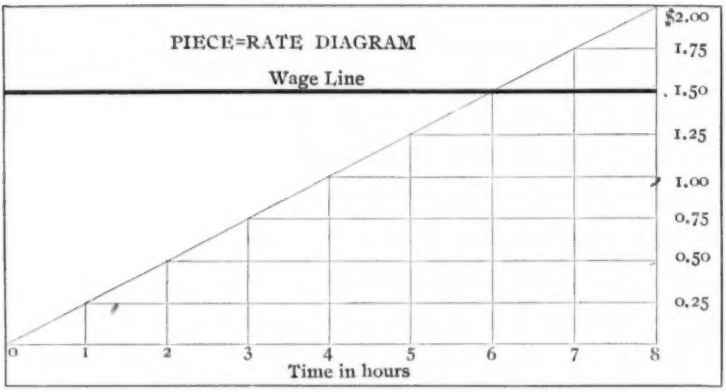


FIG. 2. DIAGRAM SHOWING EFFECT OF PIECE RATES ON WAGES.

The slant of the wage line may be at any angle from horizontal, straight piece rate, to coalescence with day-rate line. This system possesses at least four valuable points:

1.—It pays day rates if a longer time is taken than standard.

2.—It is a very flexible system and can be adapted to different conditions.

3.—It lessens but does not obviate the necessity of changing rates.

4.—It lessens but does not wholly remove the inclination to limit output.

It is in one respect a step backward, since it substitutes uncertainty for definiteness as to wage costs. Nevertheless the Halsey system

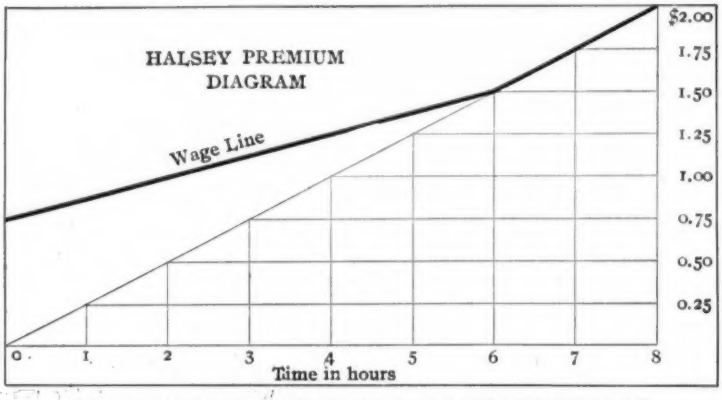


FIG. 3. DIAGRAM SHOWING OPERATION OF HALSEY PREMIUM PLAN.

was an admirable step in advance. Usually the worker is given either one-half or one-third the time he saves. Psychologically it is much better than piece rate, since most workers are more inclined to lessen their time than to increase the number of pieces turned out. A man will deliberately decide that he ought not to turn out more than five pieces a day, but he will not feel the same desire to avoid breaking his own record of two hours per piece.

Under the Halsey system, no limit is placed on a man's earning power per hour, and also a minimum piece rate of one-half or one-third the initial rate per piece is allowed, so that if a man worked on his own time he would at least receive per piece one-half or one-third standard pay.

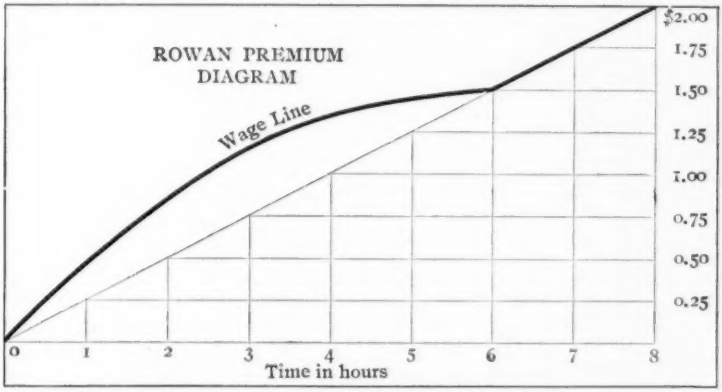


FIG. 4. DIAGRAM OF ROWAN PREMIUM SYSTEM.

THE ROWAN SYSTEM.

This is a peculiar modification of the Halsey system and rests on assumptions both fallacious and inhuman.

The theory is that however great a man's efficiency, he must not be allowed under any circumstances to earn more than double pay. Therefore if a time is set at six hours, and the worker saves 10 per cent, or 36 minutes, he is allowed an increase of 10 per cent in wages. If he saves 20 per cent, or 72 minutes, he is allowed 20 per cent increase in wages. If he saves 90 per cent of the time, or 324 minutes, he is given 90 per cent increase in wages. *If he saved all the time he would get nothing, either in wages or premium.* Also, he obtains no more bonus per piece for reducing the time 90 per cent than he does for reducing it only 10 per cent. If two men, therefore, had the same premium job of 6 hours, and one did it in 36 minutes and worked the

balance of the day at day rates, while the other did it in 5 hours and 24 minutes and worked the balance at day rate, both men would receive the same total wages and the same premium, although one had done ten times as much work as the other.

The excuse for the plan is as fallacious as its theory. It is assumed that bad mistakes may be made in setting the initial time, and because the worker is prevented from earning a high premium therefore the wage payer avoids risk of loss from excessive pay. This is however an entire mistake. If initial times are set 25 per cent too high, the workers will be regularly paid 20 per cent more than they legitimately deserve, so that for moderate mistakes, the Rowan plan pays more than the Halsey plan. The Rowan plan is in reality nothing but a day-rate plan, with a slight premium to those day workers who come down to a certain limit. It might properly be called a differential day-rate plan. A slight modification of the Halsey plan is one in which the premium does not begin immediately.

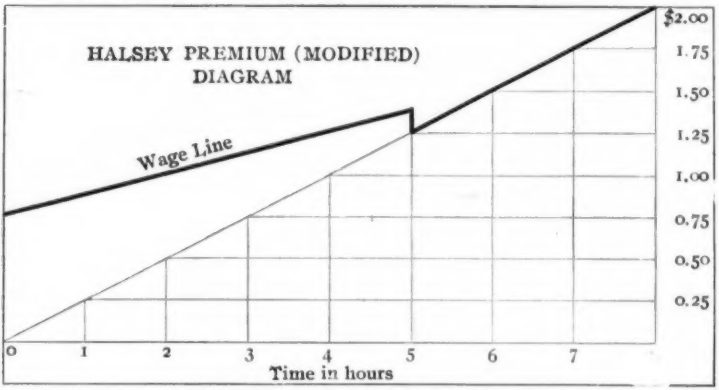


FIG. 5. DIAGRAM OF HALSEY PREMIUM PLAN, MODIFIED.

TAYLOR DIFFERENTIAL PIECE RATE.

A fundamental departure was made by Mr. Fred W. Taylor, in his differential piece-rate system. Mr. Taylor does not establish an initial time by guess or by assuming a more rapid gait than on day work, nor does he appropriate other unscientifically determined times. His method is to standardize all conditions in the shop, to make them as perfect and smoothly acting as circumstances will permit, and then to determine a reasonable minimum time in which the job can be done. As a result, Taylor's standard times are very much lower and also very much more carefully and accurately determined than under

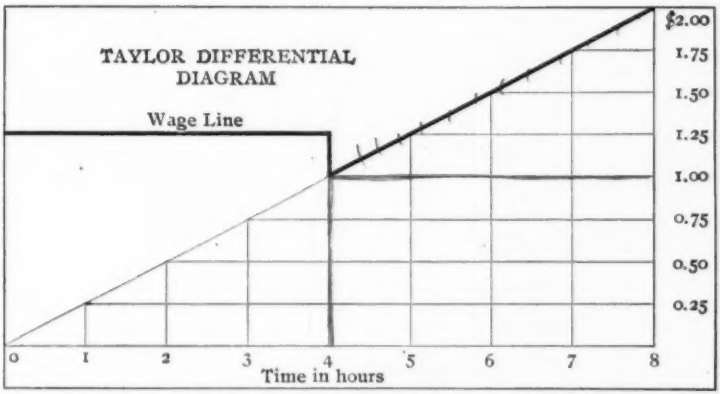


FIG. 6. DIAGRAM OF TAYLOR DIFFERENTIAL PIECE RATE PLAN.

any system hitherto considered. Mr. Taylor scorns the suggestion that by any chance the worker could earn excessive wages. Any wages that an unusually efficient worker can earn are legitimately his own. Assuming that under the Taylor system a worker should do four pieces in 4 hours, his wages for the time would be $1.00, but Mr. Taylor allows an increase of 20 per cent, 25 per cent, 30 per cent, or even more, according to the class of work, for attaining standard time. Let us assume 20 per cent increase. The worker then receives for four pieces in 4 hours, $1.20, a rate of $0.30 each. For less than four pieces the maximum hourly rate is $0.25, therefore $0.25 each. If the worker only delivers three pieces in 4 hours, his earnings are only $0.75, or $0.1875 per hour. Mr. Taylor's system awards therefore a heavy and increasing premium for high efficiency, a heavy penalty for low efficiency.

The method of standard-time determination is so rigorous that the worker cannot figure on curtailing his output. He has to hustle to make wages even at the low piece rate, and if he succeeds in this a very little extra effort will give him a higher piece rate.

The excellence of the system lies in the accuracy with which proper rates are predetermined. It is, however, somewhat inflexible and not so well adapted to work in which unforeseeable variations in time occur.

THE GANTT BONUS SYSTEM.

Mr. Gantt, a disciple of Mr. Taylor, introduced at the Bethlehem Steel Company a bonus plan.

As in Mr. Taylor's system, the proper time is most carefully and

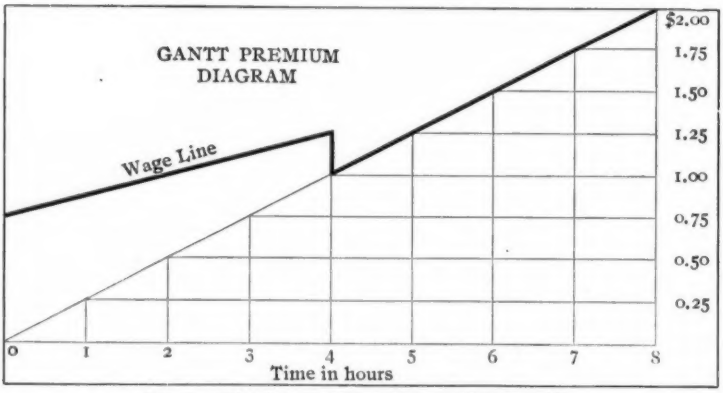


FIG. 7. DIAGRAM OF THE GANTT PREMIUM PLAN.

accurately predetermined. If the worker reached the proper time he is given a bonus of 25 per cent above normal wages for the time. If he does still better he is given half of what he makes, as in the Halsey plan. If he does not reach standard time he is paid only 75 per cent of normal wages for the excess time, provided bonus earned permits the imposition of this fine. If he had bonus to his credit he would not be fined, however much he fell below standard.

This system has shown certain psychological disadvantages in practice:

1.—The men have made it a point of semi-honor, among themselves, not to do better than standard times.

2.—Although the actual fines for failing to reach standard times were insignificant, the men claimed that they were being robbed of thousands of dollars in this manner. Neither fall-downs nor ability to lessen standard time are always up to the man. It is therefore unfortunate, when a favorable chance occurs to lessen time, that the worker deliberately holds back. It is also often unjust that he should be fined for what may not be his fault.

Actual experience with these different wage systems brings out the fact that psychology accounts for quite as much as any other condition, and that a good wage system must not only be fair but must also hit the men right.

Emerson Efficiency System.

The most recent wage system is the "Efficiency System," evolved and perfected in theory by Mr. H. Emerson and his assistants and practically applied by the officials in the shops of the Santa Fé Railway.

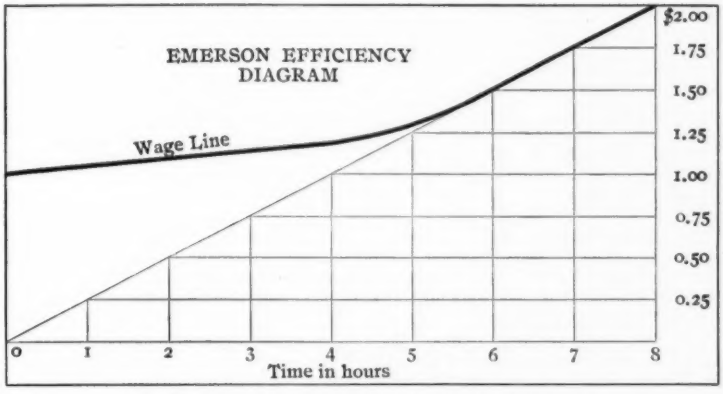


FIG. 8. DIAGRAM OF THE EMERSON EFFICIENCY PLAN.

This wage system superficially resembles the Halsey line, but in theory and in fact differs radically from all previous wage systems, although it embodies much that was best in all of them. It retains the principle of day pay irrespective of performance. It retains in modified form the principle of a flat piece rate. Like the Halsey system, it pays more per piece for less competent work. Above all, it retains Mr. Taylor's and Mr. Gantt's principle of accurate and scientific shop organization, including standard times for every job and operation.

It pays a high premium above wage or piece rate for co-operation or assistant foremanship on the part of the worker, and finally, as part of regular and daily shop practice, it revises erroneous schedules whether they be too low or too high, and it makes this revision without lessening the earning power of the worker. In addition it substitutes for the costly, annoying, inaccurate time recording of each job, a general monthly efficiency record which covers the shop as a whole, each department, gang, foreman, worker and job and, based on accurate study and efficiency, it predetermines, before work is begun, the absolute cost of every operation.

These results are facilitated by recognizing that the attainment of standard conditions as to all operations depends on four totally different elements:

1.—The shop itself must be highly organized and efficiently operated. This is a duty that devolves solely on the management, and for poor organization and operation the worker is not responsible.

2.—The character of the work itself, the quality of materials, etc.,

may vary greatly on the same job at different times. Neither manager or worker is wholly responsible for this variation.

3.—Assuming standard shop and work conditions, the worker himself can do much to co-operate with the management in making the other conditions as well as himself effective.

4.—Costs should be standardized for the shop on a basis of normal conditions and be adjusted in the counting room on the basis of the monthly efficiency factor.

a. As an incident to high shop organization and efficient operation, the standard time required for every job should be scientifically ascertained.

b. To eliminate accidental and unavoidable variations in material, etc., the worker is allowed to sum the standard times of all his jobs, gaining on some, losing on others, averaging closely even.

c. For co-operating with the management in eliminating wastes, the worker is paid a 20 per cent bonus for an efficiency of 100 per cent, which means, that the time taken for all his jobs must be equal to the standard times allowed for all his jobs. If he takes 10 hours on a 1-hour job and 1 hour on a 10-hour job, his average remains 100 per cent.

d. The same work is assumed to be done always in the same standard manner. Variations from standard are a general charge or credit to shop efficiency, not a specific variation in cost. A train passenger is not charged more because his train has been delayed by a snow storm, or less because a fair wind and a clear track made the particular train run less costly than usual.

Under the efficiency system the worker is entitled to standard day rates, even if he is doing nothing. If, however, by reason of special individual effort or skill, he does his work faster, he is entitled, not to a part (one-third or one-half, as in the Halsey system, or less, as in the Rowan system), but he is entitled to be paid in full for *all* the time he saves. As he has not less co-operated with the management, he is, in addition, entitled to 20 per cent bonus for all the time he works.

Therefore, if a worker whose pay is $0.25 per hour delivers 300 hours of jobs in a month of 250 working hours, he receives:

1.—250 hours at $0.25	$62.50
2.— 50 hours saved, at $0.25	12.50
3.— 20 per cent on 250 hours pay	12.50
Total	$87.50

If however the worker does not so co-operate with the management as to make the shop operate at high efficiency, himself included, he does not receive as much extra pay, but a lessening amount until at 67 per cent and below he is paid day rate and no more.

The diagram shows plainly the efficiency wage line beginning at 6 hours, showing 20 per cent increase at 4 hours, standard time, and paying 4 hours time even if the work took no time at all—a condition that arises practically quite often, as when a worker runs two jobs at the same time, or when he does work on his own time.

While the diagram can be applied to a 4-hour job, the worker is not paid by the separate job, but is paid straight day wages and a bonus for his full pay period efficiency. For each per cent of efficiency there is a corresponding increase in pay.

For 100 per cent efficiency the increase is 20 per cent, and for each 1 per cent increase in efficiency above an efficiency of 100 per cent, the pay also increases 1 per cent; therefore for 120 per cent efficiency the pay is increased 40 per cent. Below 100 per cent the pay table runs as follows:

Efficiency. Per cent.	Additional Pay. Per cent.
67	0.
74	1.
80	3.27
85	6.17
90	9.91
95	14.53
100	20.

The system has other merits:

1.—It standardizes not only the work of each worker, but also of every foreman, every department, and of the shop as a whole.

2.—It therefore standardizes the shop cost of every job whether it is done by a cheap apprentice in two hours, or a high priced mechanic in 10 hours. The average shop or department efficiency factor equalizes accidental variations.

3.—It separates absolutely all questions of wage rate from question of output, shop conditions, or individual excellence.

4.—It fines the management heavily if shop conditions are not maintained so as to realize standard times.

5.—It puts no limit on the ambition or earning power of any man.

6.—Standard times are being constantly corrected. If the standard man cannot average 100 per cent on his schedules, it is evident that some of them are too short and ought to be lengthened. If on the other hand, a new machine tool is introduced, new schedules are

drawn up for it, but the worker will not, on that account, make less than he did on the old schedules.

The effect on the worker of these different systems is most plainly revealed by tabulating the results with the assumption:

1.—That he does no work in all his time.

2.—That he does standard work in standard time.

3.—That he does all his work in no time.

System.	No Work in all the Time.	Standard Work in Standard Time.	All Work in No Time.
Day Rate.	Full wages.	Full wages.	No pay.
Piece Rate.	No pay.	Normal pay.	Full piece rate pay.
Halsey Premium.	Full wages.	Full wages.	⅓ to ½ piece rate pay.
Rowan Premium.	Full wages.	Full wages.	No pay.
Taylor, Piece-Rate differential.	No pay.	Bonus above normal pay (higher piece rate).	Full higher piece rate pay.
Gantt Bonus.	¾ to full pay.	Bonus above normal pay.	½ of time saved at bonus rate per hour.
Emerson Efficiency	Full wages.	Bonus above normal pay.	Full piece rate pay.

The efficiency system virtually gives the worker his choice between a day rate and a piece rate, and as the day rate is much more costly to the management, the latter pays a premium above day rate or piece rate for efficiency.

Overhead charges are not considered in this discussion of wage systems. It may be said however that overhead charges are not proportional either to time worked or to total of wages paid, but they follow their own laws. If a plant is wholly shut down there is a large overhead charge due to the general items comprised under the heading rent, as depreciation, insurance, interest on investment. If a plant owing to press of orders suddenly doubles shifts, working 20 hours a day instead of 10 hours, overhead charges are also greatly reduced. Overhead costs should be standardized, so that from month to month they may vary only slowly.

It is too much to expect that any system of paying wages will prevent an outbreak of selfish interests whether of employer or wage earner. There will however be a distinct gain if the nature of the disagreement can be made entirely distinct and plain. Clear thinking must precede clear acting, and this description of different wage systems may contribute towards clearer conceptions and more just practice.

EDITORIAL COMMENT

Prosperity Returning.

THE reassurance resulting from Taft's election seems to be spreading faster and causing a more substantial business revival than a conservative expectation might have conceived; and even if there should be some slackening of the pace later, pending the selection of the cabinet and the definition of a tariff-revision programme, the curve will still extend upward. Most of our depression has been the product of a state of mind rather than a state of facts. Anything, therefore, that betters the public temper relieves at once the brake that has been checking the advance of business. And as far as material conditions are concerned, everything is ripe for a period of extraordinary expansion. Stocks are exhausted, supplies consumed, material and equipment worn down to the point where repair and renewal are imperative. When the first move toward renewal of activity is made, the impulse passes through the whole cycle of our industries and returns, multiplied in energy, to its point of origin. Expansion, like depression, is self-propagating and self-multiplying.

The symptoms generally are encouraging to the expectancy of a sane and sound national growth. The new Administration is pledged to correction of the errors and sins of economics and finance from which the country has been suffering, and the character and temperament of the new President are assurance that the removal of the diseased tissue will be accomplished with a minimum of shock to the sound. We may hope for persistence in all that was good in the Roosevelt policies, without that which was destructive in his methods.

Passing of Piracy.

THE conviction of Morse and Curtis, like the exile of Napoleon or the hanging of Captain Kidd, is one of those startling signs by which, from time to time, the world is advised of progress in evolution to a new stage and is spurred to realizations of new ideals making progress in the new order swifter, and return to the old order impossible.

The parallel is perhaps closer than might be granted at first thought. The enormous development of industry and commerce, and hence of the financial system, during the past few decades has opened fields for enrichment—or for pillage, if you please—more seductive than Gaul ever spread before Caesar, more alluring than the Indies afforded to the adventurers of Spain. Every era in the world's history that spread new vistas of this kind has witnessed also outbreaks of destructive activity on the part of unscrupulous men who were partly quicker than others to see selfish advantages in a new condition of affairs, and partly nearer to the beasts of prey in their lack of conscience in seizing whatever their skill enabled them to grasp and their strength enabled them to hold. But those are not the healthy, but the unhealthy, phenomena of growth and change—the abuses which seem to be always incident to an epoch of change.

They pass and disappear with progress in the general mastery of knowledge and understanding as to what is best for society at large under the new conditions. They are abated not by arresting the whole development, and possibly not so much as is generally thought by legislation and punishment, but rather by a general change in the temper of the world which makes the evil act unthinkable and the position of the evil doer intolerable.

In the days when the greatest prowess the world knew was military, it was the "man on horseback" who waded through blood to power and fortune; but it would be inconceivable that we should have another Napoleon today. The rise of commerce and traffic oversea, with or without that very elastic institution known as "letters of marque," saw the development of piracy to the rank almost of the gentleman's occupation; but piracy has disappeared from the earth, or rather from the ocean. The first great era of railroad building in this country brought with it our now notorious generation of millionaire railroad wreckers; but we must admit that the railroad world has purged itself pretty thoroughly of that disease, or at least that our great lines now are generally administered with honesty and faithful regard for the interests of the security holders.

It is not to be denied that the hanging of pirates and the jailing of dishonest railroad presidents has its effect in stimulating a change of sentiment; but the great cause after all is the altered public opinion which makes the hanging or the jailing possible. To borrow a simile from bacteriology, these poisons that germinate in the body politic, and seem sometimes to be increasing to fatal proportions, appear also to develop their own anti-toxins by which they are finally checked and destroyed. The world no longer lives in fear of an Alexander or a Napoleon, but its confidence is not based upon abolition of the military system which gained Napoleon his opportunity. We still have standing armies far more powerful than those with which Napoleon conducted his campaigns, but in general they inspire in the minds of the Nation feelings of comfort, security and protection. Inevitably, our great industries and financial undertakings must follow the same trend. Trust managers must increasingly appreciate (as some of them do already) that their own best interests are served when they share, to the greatest extent possible, with customers and employees and through them with the public, those advantages in manufacturing which vast organized facilities give. Unquestionably, the conviction of Morse will make other Napoleons and pirates of finance hesitate, but the great significance is that sentiment is changing so that such convictions are possible. It is a step toward the time when men of the stamp of Morse will be as impossible as Napoleon or Kidd would be today.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE SCIENTIFIC CONTROL OF FUEL CONSUMPTION.

A PLEA FOR MORE SERIOUS CONSIDERATION OF THE PROBLEMS OF COMBUSTION AND FUEL ECONOMY.

Henry E. Armstrong—Iron and Steel Institute.

A STRIKING plea for the scientific control of fuel consumption is made by Prof. Henry E. Armstrong in a paper presented under the above title at the recent meeting of the Iron and Steel Institute. In introducing his subject, Prof. Armstrong comments upon the gradual exhaustion of coal supplies and emphasizes the necessity for the employment of efficient and economical methods in the use of all classes of fuel. The main point of his argument for a more serious consideration of the problems of combustion and fuel economy are given in the following extracts from his paper.

"But two courses are open: the one involves economy and such improvements as are possible in the practice of present methods of consuming fuel; the other the introduction of methods which are potentially of higher efficiency. In either case success can arise only from more attention being paid to the root conditions of the problem.

"Great advantage is to be derived from the employment of automatic methods of registering continuously the extent to which the oxygen in the air is utilised—because this affords a check on the manner in which fires are attended to, and is therefore a means of securing regular stoking; also because undue loss of heat is avoided if care be taken that the maximum proportion of carbon dioxide is present in the gases escaping into the flues. The use of automatic apparatus of the Callendar type for the continuous registration of temperature is also, for similar reasons, often of importance, and becomes indispensable when the maintenance of a steady heat is a condition of success; it is well known that marked economy in blast-furnace practice has been secured by such means in recent years. The need of paying attention to the maintenance of steady conditions, moreover, at all times has a moral effect on workmen, the value of which cannot well be overrated. But my object on the present occasion is to plead for something more than the mere occasional control of fuel consumption, whether in iron-works or elsewhere: it is to plead for the introduction of a new attitude towards the problems of combustion and of fuel economy; an attitude of understanding based upon sympathetic and serious contemplation of the phenomena—an attitude of real and deep appreciation.

"Ignorance, indeed, has not a little to do with our difficulties, as these arise in no slight degree from our calm contempt of the complexities which surround the whole subject of combustion. Everyone, of course, knows that fire is produced by the oxygen of the air combining with the carbon and hydrogen of the fuel; few realize, however, that the statement is but the barest gloss upon the facts. The chemical student writes C +

$O_2 = CO_2$ and hey-presto! feels that he has said all that the examiner can demand. And while coal is treated as of some consequence because it is paid for in hard cash, little consideration is given to the part which air plays; the fact that it is equally worthy with coal to be treated as fuel is seldom recognised; air being always at hand, it is supposed that it costs nothing; in reality its use is often attended with no inconsiderable expense (apart from that involved in the construction of the smoke-shaft), sometimes because it is used too sparingly, but more often because it is used too lavishly.

"The extraordinary complexity and wondrous beauty of the phenomena of combustion is only beginning to dawn upon us—even the problems to be solved are perceived only dimly; the fire sense has yet to be cultivated." Not very many years ago carbonic oxide, hydrogen and charcoal were considered merely as combustible substances, any one of which would be sure to inflame in the presence of oxygen on the application of sufficient heat. The discoveries of H. B. Dixon in 1883, and of H. Brereton Baker in 1885 and 1902, of the important part played in combustion by moisture, exposed the fallacy of this simple belief and worked a revolution in our knowledge of the phenomena of combustion. The combustion of the hydrocarbons is another point on which the old simplicity of belief has been rudely disturbed. The process is now understood to be one of extreme complexity; the final products, carbon dioxide and water, are but the end products of a whole series of changes which separately escape attention because of the extraordinary rapidity with which they take place.

"It is impossible to understand the changes which attend the combustion of carbonaceous fuels without considerable appreciation of organic chemistry. But we are only at the beginning of our knowledge of such matters. We know almost nothing of the influence of surfaces on the interchanges involved in combustion, except that they exercise a profound influence. And yet all furnace operations are carried out within boundaries—within boundaries which presumably play a determining part beyond that of a mere enclosure. Almont the only practical worker in this field was the late Frederic Siemens, whose name is so well known together with that of his brother, the late Sir William Siemens, in connection with the regenerative furnace; but his labours seem to have passed into oblivion. No subject is of greater importance from a practical point of view. The effective use of gaseous fuel in the future for the purpose of raising steam and in many other ways, especially in substitution for our present wasteful system of domestic heating, must depend on the advance of knowledge in this field. The inefficiency of gas-stoves as now supplied does not bear thinking of. If gas engineers had any understanding of such matters—any scientific conscience — and were not merely engaged in producing gas for sale, with little reference to quality and the results obtained by its use, so long as mere statutory obligations are satisfied, they would hesitate before advocating the employment of the appliances now foisted upon an unwary public. Clear proof that advance is possible is afforded by Auer von Welsbach's discovery of the incandescent mantle; but it is worth while noting that the effective radiant in the mantle is a substance present to the extent of a little more than a fraction of a per cent., and that at most two or three substances are known to be available for the purpose. How long the supply of these materials will hold out we cannot say, but the question is one of no little importance.

"Fuel is like food, quality being of importance as well as quantity. In the first place, the constituents which remain as ashes merit more attention than they receive. The possibility of preventing clinkering by mixing different varieties of coal or by suitable additions is rarely taken into account. The escape of sulphur also receives no proper attention—it probably constitutes a far more serious nuisance than that of smoke production, owing to the effects produced on vegetation and on buildings, especially on iron structures; it is also not improbable that it contributes to no inconsiderable extent

to produce fog. Being invisible, the sulphur compounds in smoke do not openly invite resentment; yet the subject is one which must attract public attention at no distant date, if only as a consequence of the unbridled license now allowed to gas engineers.

"To pass to the most important side of the subject, it should be pointed out that fuel is not to be judged only on account of its heating power as determined in the laboratory. Thus hydrogen and carbonic oxide gases have practically the same heats of combustion, measured at ordinary temperatures at which water is liquid; at temperatures at which water is gaseous, however, the heat of combustion of hydrogen is reduced in value to the extent of nearly one-eighth, and falls considerably below that of carbonic oxide. Of the two, carbonic oxide is therefore the more effective fuel; moreover, perhaps owing to its peculiar insensitiveness to oxidation, it seems to be in a measure a milder fuel, and the products of combustion of the two gases—water and carbon dioxide—appear to exercise very different effects; in the re-heating furnace, for example. Refinements such as these, however, have scarcely entered as yet into consideration in manufacturing operations; it has to be recognised that they are of consequence in connection both with the production and with the use of producer gas. In course of time it may also be considered desirable to pay some attention to the composition of the gas supplied for domestic purposes—to deliver a product produced by some more rational process than that involved in coking coal. But so long as the manufacture of gas rests with the engineer alone and not with the chemist, the public must suffer the consequences which always attend imperfect administration.

"In the case of solid fuel, it is well known that no two coals yield quite the same quantity of flame, and that mechanical differences also play an important part in modifying combustion; apparently it is chiefly because changes take place which involve mechanical alterations, not because there is any material loss of calorific power, that steam coal loses its value when stored for any considerable period. The advantage derived from mechanical stoking probably does not arise merely from its being more economical, but also from the fact that combustion takes place in a more nearly uniform manner than when coal is introduced at intervals, the flame retaining its character in consequence of the steady introduction of bituminous matter from which hydro-carbons are distilled off, which burn with a more or less luminous flame. These are all matters which, in the future, must receive much more attention than they have received in the past—the study of radiation phenomena is yet in its earliest infancy.

"But it should be added that, if fuel is to be economised, it will be necessary at the same time to pay attention to the boiler as well as to the fire; the value of water-softening appliances is still far too generally overlooked.

"To pass from the consideration of methods in use to that of methods potentially of far higher efficiency than any of the purely thermal processes now at our disposal, we can at present only look forward to the direct conversion of the energy latent in fuel into electrical energy. To say that this is impossible would be absurd, but it is useless to exaggerate the difficulties. Hydrogen can be burnt electrically in the Grove gas battery, but there is no economical process of preparing hydrogen; it can, however, be obtained by passing steam over red-hot coal, but only in admixture with carbonic oxide. Why not burn such a mixture electrically? it may be asked. Strange to say, not only are we unable to substitute carbonic oxide for hydrogen in a gas battery, but it puts a stop to hydrogen being used in one if mixed with it. Why this difference should obtain between the two gases, both being combustible, we scarcely know, although we may guess at the reason. Why carbonic oxide should hinder the electrolytic oxidation of hydrogen at present entirely passes comprehension. It is problems such as these that we need to solve before any substantial advance can be made. No one has yet succeeded in making a satisfactory voltaic battery

with carbon; and before coal is burnt electrically it will certainly be necessary to make it a conductor of electricity. All these are tasks which we should aim at executing, whatever the difficulties, the solution of such problems being of infinite importance to mankind.

"I have thus drawn attention to the complexity of the issues involved in the proper use of fuel, in order that it may be clear that, if we are to advance and effect the economies which we are morally bound to aim at introducing with the least possible delay, a more philosophical treatment must be secured for the subject. We need both to dispel public ignorance and to excite public interest in such matters. This can only be done by schools."

Engineers are now beginning to appreciate the importance of a knowledge of chemistry. "But in the works the engineer must remain an engineer; his mental attitude can never be that of the trained chemist; in all operations involving the occurrence of chemical changes the chemist must be at his side, otherwise the work can only be conducted in an empirical and more or less perfunctory manner. I believe this to be one of the great lessons to be learnt by English manufacturers at the present day. The chemist is rarely employed in our works. The majority of those called chemists in works are not chemists in any proper sense of the term, but merely 'analysts' engaged in controlling the quality of the materials used and of the products; more often than not, they are not allowed access to the works proper, and have little or no opportunity of becoming chemists by familiarising themselves with the actual operations and by reflecting on and inquiring into the nature of the changes which are involved in the processes. Worst of all, they are not called upon to undertake systematic research work. The great success of German manufacturers in recent times is far less a consequence of the training given in the universities and technical schools than it is of the establishment within the works of research laboratories in which the problems the industry affords are systematically studied. Until the German example is followed, we shall do little to place our industries on a scientific basis, as the proper scientific atmosphere and spirit must be lacking in the works, and the opportunities which they afford must necessarily remain unheeded and unexploited."

THE INFLUENCE OF SILICON ON THE PROPERTIES OF IRON.

THE MODIFICATION OF THE MAGNETIC AND CHEMICAL PROPERTIES OF IRON BY THE ADDITION OF SILICON.

A. Jauve—Iron and Steel Institute.

IN our issue for May last, reference was made in these columns to the acid-resisting properties of iron-silicon alloys of high silicon content, in a review of a paper read before the Société des Ingenieurs Civils de France by M. A. Jouve, to whose researches is due the development of the "métillures" industry, which has attained to considerable proportions on the Continent. The information given in this paper was of a general character, and we are glad to supplement our former review with the following abstract of a paper read by the same author at the recent meeting of the Iron and Steel Institute, which, in addition to fuller details as to the chemical properties of iron-silicon alloys, gives some interesting data on the influence of silicon on the magnetic properties of iron.

"Iron and silicon in combining give rise to three compounds, and it would seem to have been demonstrated that it is impossible to have any further combinations than these three, which are:—Fe_2Si, FeSi, and $FeSi_2$, unless it be below the lower limit Fe_2Si, or above the upper limit $FeSi_2$. The first and the last of these combinations crystallise definitely as prisms, and FeSi crystallises in clearly defined tetrahedra. Crystals have, indeed, been obtained measuring several millimetres to the side.

"Silicon is a metalloid which is in *no* way magnetic—that is to say, the field of an electro-magnet exerts no influence, and therefore exerts no attraction, on pure silicon. On the other hand, iron constitutes the typical magnetic metal. It appeared to the author that it would be of interest to ascertain if the variation of magnetic attraction was in simple proportion to the percentages of iron and silicon, or whether there were any modifications in the resultant of this electric phenomenon. A special research was made by the author to determine if such were the case, and a portion of this research has already been published by him in 1902, of which the following is a brief summary:—

"The principle involved is as follows: If iron, alloyed with varying proportions of silicon, is subjected to the influence of an electro-magnet excited by a current of constant intensity, the attractive power of the latter diminishes proportionally with the increase in the percentage of silicon in the alloy until the ratio of 20 per cent. of silicon, corresponding to the composition Fe_2Si, is reached, when there is a sudden inflexion in the curve. Beyond this point the magnetic susceptibility again decreases regularly until FeSi (33.33 per cent. Si) is reached, when another break occurs, and subsequently the same thing happens at $FeSi_{1/2}$ (50 per cent. Si). Except at these three points, the magnetic susceptibility decreases proportionally to the increase of silicon, from 100 for pure iron to 0 for pure silicon.

"For the three compounds Fe_2Si, FeSi, and $FeSi_2$, the curve undergoes three distinct inflexions, as stated, and it is a remarkable thing that it undergoes no other modifications than these. It would therefore appear established beyond doubt that no other definite compounds of silicon and of iron exist other than Fe_2Si, FeSi, and $FeSi_2$. The preceding results were those obtained with pure alloys of iron and silicon, synthetically prepared, and entirely free from carbon. The percentage of carbon has an influence on the result obtained, and the author proposes in a future paper to study the variations produced by the amount of carbon present. It is necessary here to note the fact that the percentage of carbon for alloys rich in silicon is decidedly small, as there is marked antagonism betwen silicon and carbon when the percentage of the latter reaches in the neighbourhood of 15 to 20. An investigation of this phenomenon has been the object of the author's researches, which will be published in a future paper.

"As has been pointed out above, the increase in the percentage of silicon is accompanied by a diminution in that of the carbon, and the latter diminishes rapidly with percentages of silicon comprised between 15 and 20 per cent., and finally falls below 1 per cent. once 20 per cent. of silicon is reached. This probably explains why it is that ferro-silicons with a percentage of silicon averaging from 14 to 18 per cent. reveal numerous cavities filled with the graphite resulting from the dissolution of the carbon in the iron of the ferro-silicon during fusion. This carbon is subsequently almost entirely separated during cooling owing to the presence of silicon. The silicon confers on the iron peculiar properties which characterise it alone. The most characteristic property is the resistance of the iron to acids. The author has proved for some time past, and all analytical chemists who have to carry out analyses of alloys of iron and silicon have similarly established the fact, that these alloys do not dissolve in acids—except in hydrofluoric acid—even under special conditions, as in the Carius method, which consists of treating them, under pressure, in nitric acid. The author has often been impressed with the interest which would attach to these observations if this property could be utilised in the construction of vessels for use with acids. The researches detailed below are the result of six years' investigation of the subject.

"Not all the acids—and the author would define as an acid all bodies having an acid reaction with iron—react in the same manner on iron alloyed with silicon, and the true resistance to corrosion is not obtained until the proportions corresponding to Fe_2Si are exceeded—that

is to say, it is necessary to exclude, to begin with, all silicon alloys prepared otherwise than in the electric furnace, inasmuch as it is this apparatus alone which permits of alloys with high percentages of silicon being obtained.

"The alteration in the susceptibility of the metal to attack by sulphuric acid is such that, under proper conditions, it is possible directly to concentrate dilute sulphuric acid at 20 degrees to 25 degrees Baumé to 66 degrees Baumé without changing the apparatus, and also without introducing any iron into the acid. Even in works where the contact method is employed, and where vessels of ordinary cast iron are but little corroded, there is an advantage in employing alloys of iron and silicon owing to the great resistance of such alloys as the life of the apparatus is very much lengthened.

"Tests have ben carried out on basins, tubes, pipes, tubs, and vats; some of the results are as follows:—

1. Silicon alloy (métillure), hot sulphuric acid (22 degrees Baumé). Loss after two months = 0.06 per cent.

2. Cast iron containing 3 per cent. of silicon. Loss in two hours = 44.6 per cent.

3. Ordinary cast iron. Loss in two hours = 46 per cent.

"The difference in these results is very marked, and it must be added that the alloy employed contained only 20.6 per cent. of silicon, while the cast iron contained 3.3 per cent.

"When dealing with nitric acid it is necessary to increase the percentage of silicon, as the corrosive action of nitric acid is considerably greater than that of sulphuric acid. The results obtained have nevertheless been remarkable. (A.) A pipe conveying 660 lbs. of nitric acid vapour at a temperature of 150 degrees to 200 degrees C. in 24 hours withstood successfully from March, 1903, and the loss on the original weight has been but a few ounces (about 3½ ounces on an original weight of 45 lbs.). (B.) It has been found possible directly to concentrate nitric acid from 36 degrees Baumé to 48½ degrees Baumé without the formation of nitrous oxides by means of these alloys. (C.) In a particular instance a ventilating fan has been constructed of silicon alloy, and delivers 250 cubic metres per minute of a mixture of nitric and sulphuric acid vapours.

"The results obtained with hydrochloric acid have been fewer on account of the lack of opportunities of testing, but the applications of the alloy already made have been of interest.

"The employment of the alloy for the construction of apparatus for acetic acid has given the following comparative results:—

COEFFICIENT OF CORRODIBILITY.

	Per cent.
Tin	0.8
Copper	11.0
Lead	19.0
Silicon alloy	2.0
Iron	44.0

"The alteration in the nature of the metal is such that in, for example, the drainage water from pyritic mines and in the bilge of ships, in dealing with which wrought or cast-iron pipes are rapidly attacked, it has been possible to replace them successfully by silicon alloys in the construction of drainage pumps."

M. Jouve gives a number of tables showing the results of commercial tests as to the chemical resistance of the "métillures" to corrosion. We reproduce a typical example:

IMMERSED IN VARIOUS ACIDS AFTER 24 HOURS.

Acid.	Weight, Kilogrammes.	Loss of Weight, Kilogrammes.
Nitric con.	42.1690	0.0060
Nitric 1 : 1	38.6405	0.0065
Sulphuric con.	32.6000	No change
Sulphuric, 1 : 1	27.9800	No change
Acetic, con.	19.5632	0.009
Acetic 1 : 1	14.373	0.014

"The results which are given above are derived from tests made from the actual commercial point of view, and the weights and dimensions of some of the apparatus fully demonstrate the value of the alloys. Thus, a vat of 6.8 feet in diameter, weighing about 2 tons, has been employed for a mixture of sulphuric and acetic acids. A stirrer weighing 770 pounds was employed for the same object. Pipes weighing about 1,760 pounds, and having a length of 9 feet, have also been employed for conveying sulphuric acid. An apparatus for the concentration of sulphuric acid permit-

ted of a yield being obtained of 10 tons of acid concentrated from 50 to 52 degrees Baumé to 66 degrees Baumé per diem.

"In short, it may be seen from the foregoing examples that in cases where the silicon added to the iron attains a sufficiently high percentage, (1) the magnetic properties diminish, and (2) the resistance to the action of acids increases with the proportion of silicon. In the first instance they become nil, and in the second it becomes almost negligible."

REPAIRS AND DEPRECIATION IN MANUFACTURING PLANTS.

A SUGGESTED SYSTEM FOR TAKING CARE OF PLANT REPAIR AND MAINTENANCE, AND THE PRINCIPLES OF PROPER PROVISION FOR RENEWALS.

James E. Darbishire—Institution of Mechanical Engineers.

A VALUABLE paper on repairs, renewals, deterioration and depreciation of workshop plant and machinery, read before the Institution of Mechanical Enginers on October 16 by Mr. James Edward Darbishire, is presented in brief abstract below. In connection with his suggested scheme for taking care of maintenance and depreciation, of which an outline is here given, Mr. Darbishire exhibited a number of forms which it is impossible for us to reproduce. We present, however, the points in his paper which aroused most discussion and on which he laid special emphasis.

Proper provision for maintenance and depreciation is far from being a matter of mere accounting; in fact, the first reform in a great many cases should be to transfer the control of the machinery stock book and everything connected with it from the accountant to the engineer. The duty of maintaining, and providing for repairs to plant and machinery is generally assigned to the works manager. It is, however, very unusual for this official to have any knowledge of the money value of the plant he is dealing with, hence the advantage of placing the control of the repairs and renewals and of valuation in the same hands, and limiting the accountant's duty to the use in his profit and loss account and balance sheet of the valuation provided for him by the engineer.

"Under the suggested system the control of everything would be vested in the works manager, or, in the case of large works, in a special official. The limit of his powers, as regards incurring expenditure, would be defined by the general manager, directors or partners according to circumstances; he would be responsible for the upkeep of the whole of the machinery and plant, and it would be his duty to report his requirements when he found them to exceed his financial limit; but it is essential that he should have considerable latitude in incurring expendintures on repairs, because obviously time is of the utmost importance in most cases, and he ought not to be bound by too much red tape; in machinery repairs 'a stitch in time' often saves many times nine. There is no doubt whatever that if the right man be appointed there will be no difficulty on this point.

"His first step must be to prepare a proper schedule of the plant and machinery in his charge, entering each item in the machinery stock book, with its distinguishing number. Against each item there should be entered its present value, calculated according to its age, in the manner to be explained later. Also a figure representing its probable life in years; this second figure will be required when provision for depreciation comes under consideration. . . . .

"The next step must be to make provision for proper care of the various machines, and for repairs being executed when required without delay. To ensure this, each attendant or workman in charge of a machine or group of machines, being the actual attendant or operator, and not a foreman, would be made, in the first instance, responsible for its being maintained in the highest possible condition, the fireman for his

boilers, the turner for his lathe, and so on. It would be his duty to report immediately to his shop foreman any defect becoming apparent, and to enter on a card the description and number of machine, nature of defect, date, and his (the attendant's) name.

"The foreman's duty would then be to inspect the machine, and if in his opinion the repairs are necessary, to initial the card, and submit it to the works manager for final authority, the works manager initialing and dating the card and assigning a Works Order Number to the job. The repairs would then be executed at once, and on their completion the machine would be inspected and passed by the works manager, and their execution certified (with date) on the card; to which would be also added the cost incurred. This system would ensure proper care by the attendants of every machine, and would prevent ill-usage, which used to be one of the workshop troubles, though in this respect the modern workmen is a great improvement on his predecessors, and the care of machines, especially machine tools, now leaves very little to be desired. It would also afford the works manager the opportunity of deciding when the time has come to replace instead of repairing, and it will be remembered that this official would have before him the 'stock book' valuation of the machine under consideration, and therefore would know how far the cost of renewal had been provided for. He would see the whole situation at a glance, and decide whether to replace, thoroughly repair, or partially repair.

"In addition to the workman's or attendant's daily watching of each machine, periodical inspection should be made by the works manager as a check upon workman and foreman, and each such inspection recorded."

In dealing with depreciation, "it is absolutely necessary to make provision for a fund by means of which the various items of a workshop equipment can be renewed from time to time, which provision obviously has to be made without any reference to the profits or losses of trade. It must be made as part of the working expenses of the businesss, and in this respect the author protests against the system frequently adopted by accountants of showing a so-called 'profit' out of which so much is set aside for depreciation, the amount apparently being at the discretion of the directors or the accountants, and frequently depending upon the amount of the so-called 'profit.' It is clearly wrong to make the provision for depreciation a charge on profits, for depreciation is really a loss of the capital assets, which has to be made good out of income, and is just as much a charge on revenue as rent or taxes; there is no escape from its incidence, and there is no profit until adequate provision for depreciation has been made. That the provision should be adequate goes without saying; the amount must be determined without reference to the result of trading but must be an absolute charge, so that the depreciation may be truly representative of the loss of value of the machinery which occurs whether trading is profitable or not."

The total loss by the depreciation of a machine is the difference between its purchase price and its ultimate scrap value. This has to be written off during its life in gradually decreasing increments by fixing a percentage, dependent upon the estimated probable life, to write off each year from the previous year's value. The amount of depreciation on each item should be determined separately. When the depreciation has been calculated for each machine in the plant, the total on the whole plant must be charged against the year's income if the balance sheet is to show the actual value of the plant and the actual profit or loss. A separate account for each item in the plant makes it a simple matter to make allowances for replacements, the effect of improvements to machines, increases in productive capacity, etc.

"The results of unsound finance in dealing with depreciation are so serious that it may surely be said that every establishment ought to be put on a sound basis, the actual present value of the machinery and plant determined, and systematic provision made for depreciа-

tion, so that when renewals become necessary, their cost is provided for. It is often stated that when a business is working at a loss, there can be no provision for depreciation, which in a sense is true, but depreciation is going on all the same, and the accounts ought to show the loss fairly and squarely—that is, the depreciation sum should be written off, whatever the results of trade. If a recovery takes place, the position is sound; if not, continued losses mean the end of the business, and the valuation of the plant at its right figure will not affect this.

"The danger of under-provision for depreciation, and especially of allowing the amount to depend upon the results of any year's trading, is that in lean years what ought to be set aside for depreciation may be entirely or partially distributed in dividends, which is nothing more or less than paying dividends out of capital. This may be done in the expectation of better times to come, when the depreciation deficiency may be made up; but it is quite unsound, and in many cases has brought about the results which might have been expected. Even now, there are too many works equipped with machinery which is so out of date as to be a serious handicap in manufacturing, but which cannot be thrown away and replaced because past years have not provided the means to meet the expense. To raise fresh capital for this purpose, even if feasible, is absolutely unsound finance, for the new machinery has to produce sufficient to provide interest on the lost capital as well as on the new.

"In fact, over-valued machinery is one of the most dangerous enemies to financial safety; it would be far better to distribute less and set aside more for depreciation, than to live in a 'fool's paradise,' and awake to find that the time has come when machinery must be modernized to meet competition, and that the funds to do this are non-existent."

THE FUTURE OF THE PACIFIC CARRYING TRADE.

THE PRESENT CONDITIONS OF COMPETITION AND THE PROBABLE ASCENDENCY OF THE JAPANESE.

Edward G. Bogart—The World's Work.

IN the two previous numbers of THE ENGINEERING MAGAZINE we have referred in these columns to the enormously rapid development of shipowning and shipbuilding in Japan, and we noted in passing the gradual diversion of the carrying trade of the Pacific to the subsidized Japanese lines and the consequent decline in the tonnage carried by Canadian and American shipping. This subject is discussed at length in *The World's Work* for November by Mr. Edward G. Bogart, who predicts that in the near future practically all the Pacific trade will be carried in Japanese bottoms. Additional interest is lent to Mr. Bogart's discussion, which we abstract briefly below, by the recent announcement that the Canadian Pacific is about to inaugurate a rate war against the Japanese lines.

The tonnage of the United States ships, those of the Pacific Mail, the Boston Steamship Company and the Great Northern, far exceeds the combined tonnage of the ships of other nationalities engaged in the Pacific trade. The Japanese, Canadian and German lines together barely equal the tonnage capacity of the three largest American ships, the *Minnesota*, the *Manchuria* and the *Mongolia*. But the trade in American ships is a losing venture all around. About six years ago, when the huge liners of the Great Northern were put in service, Mr. Hill and his associates made enormous reductions in their rate schedules in an endeavor to divert traffic from the tramp steamers and from the Suez Canal route via New York to the Pacific line. A through rate was made from the eastern cities of the United States to Japan lower than that from those cities to Seattle, and by this means the Northern Pacific and the Great Northern secured a large amount of traffic at rates that

either equalled or cut the rates via the Suez Canal.

In 1906, however, the passing of the Hepburn Act placed upon the railroads the necessity of giving thirty-days' notice of a change in rates. This provision made it quite impossible for the railroads to change their rates to meet the constant changes made by the Suez Canal lines and the latter, being unhampered by the Hepburn Act and knowing in advance what the railroads were able to do, secured the bulk of the traffic by cutting their rates to whatever figure was necessary. Very soon, too, the railroads, fearing that the Interstate Commerce Commission would order them to make domestic rates based on their export schedules, were obliged to make the regular domestic rate to the Pacific Coast the minimum rate to the Orient. The result was that the tonnage over the Great Northern and the Northern Pacific, which had reached nearly 300,000 tons in 1905, dropped to 89,599 tons in 1906, to 61,411 tons in 1907, and, it is probable, lower still in 1908.

Early in the present year the Interstate Commerce Commission was induced to modify the rule regarding advance notice of changes in rates; now the railroads have to give only three days notice of a reduction and ten days of an advance in rail and ocean rates. This restriction in itself would not prevent them from meeting successfully the competition of tramp steamers and the Suez Canal lines, were it not that they are obliged to file at Washington statements showing exactly the proportion in which the through rates they make to the Orient are divided between railroad and steamship. This, say the railroads, completely destroys the Oriental trade so far as inland shippers are concerned, for such schedules cannot be filed without running the risk of creating an agitation for the fixing of domestic rates on the same basis. Under these circumstances, and in the face of the competition of the Suez lines and tramps, the true growth of American exports to the Orient by way of the Pacific Coast will not come until the commodities imported from the United States by China and Japan, now largely produced or manufactured in the eastern States, are produced or manufactured west of the Rocky Mountains. That in the long run an immense tonnage of American goods will go to Japan and China may be taken for granted, but the real awakening of the Pacific trade awaits the growth of manufacturing in the West.

"Let it be granted that a huge American tonnage for the Orient will ultimately originate within striking distance of the Coast. Then, who will carry it? This is the second, and most significant, part of the problem. To-day, as I have pointed out, the American tonnage of liners far overtops the tonnage of all other nationalities combined. Is this a permanent condition, or must it change?

"All signs point to a change. That change will probably be brought about by the wholesale purchase of the American ships that now carry the Stars and Stripes, and their registry under another flag—the flag of Japan. The sale may not be made to-day, nor to-morrow. It will be made when the commercial genius of the Japanese decides that the time has come. Already the tonnage of the American fleets is quoted far below the cost of replacement.

"How much cheaper the Japanese may buy these ships no one can say. Perhaps they will never buy them. I don't know why they should, except at their own prices. Every student of Japan knows that to-day they can build great ships in the docks of Japan at prices that astonish us. When one takes up the Japanese report, and reads that the average wages of a Japanese shipbuilder are thirty-two cents a day, and that there are nearly twenty thousand men at work in two hundred and sixteen shipbuilding plants in the Empire, one ceases to wonder at the ability of the Japanese to turn out great ships in competition with American plants manned by builders at four dollars a day.

"In this matter of building ships, America has never excelled. That she can rival Japan, even to-day, cannot be entertained for a minute. The matter of wages is one insurmountable obsta-

cle. Government bounties are paid in Japan to every Japanese who builds a ship of 700 tons or more. To-day the Government of Japan is straining every effort to make, at its foundry at Wakamatsu, the steel plates, rivets, beams, and other parts of great ships that hitherto the Japanese have had to import at high prices. Timber is cheaper than it is here, for Japan has more than 50,000,000 acres of standing timber, and labor ranges from nineteen dollars a year to ninety.

"This item, the cost of building ships, is merely the first item in the count against American shipping on the Pacific. There remains an even more important item, namely the cost of operating the ships when built. In this matter, America is hopeless. The average wages of an American able bodied seaman, according to the Bureau of Navigation, are from $15 to $45 a month, and found. It is probably quite conservative to average the entire crew, including officers, at $30 per month apiece. The average on a Japanese liner in the same service is less than $10. On top of this, there is a difference in the cost of feeding the crew, the American sailor demanding rations that cost from 200 to 300 per cent. more than the normal rations of a Japanese crew.

"Ten years ago, when the Japanese liners were new in the trade, they manned their ships with Americans, Japanese, and Chinese. The officers were mostly American, or English, and were paid the American scale. As time went on, the Japanese sailors learned the trade. For a time, the habit was to have two captains, one white, the other Japanese. To-day the white man is quite generally discarded. The crew and officers of the Nippon Yusen Kaisha and the Toyo Kisen Kaisha are Japanese and Chinese. They have no fights with labor unions.

"The Japanese and the American ships lie side by side at the docks of San Francisco. Both interchange freight and passengers with all the railroads, under contracts. Both get the same rates. At every important point, the Pacific Mail Steamship Company and the Japanese Companies have a 'joint agency' that takes contracts for both.

"The difference is simply this—that, while the Pacific Mail and the Occidental & Oriental, American and British lines, can barely make a living and keep their heads above water on the rates they get, the Japanese fleet getting the same rates, makes a good profit. Nobody attempts to deny this fact. It is written clearly enough in the annual reports of the Pacific Mail, and you may get it from the lips of any officer of the Pacific Mail whenever you care to ask. The mere fact that the company does a gross business of $5,000,000 or so a year and makes a profit, by hard figuring, that ranges from $100,000 to $300,000, speaks for itself. While the stock of the Pacific Mail reached a maximum price of 41½ per cent. in 1907, the stock of the Nippon Yusen Kaisha, on the bourse at Tokio, sold at 300 per cent. That is the difference.

"Everyone who knows anything about shipping knows that the British can build ships, man ships, and operate ships at a cost that cannot be equaled in America. For a half-century, British commerce has ruled the seas. Her merchantmen have carried from 60 to 70 per cent. of all the trade that flowed along the paths of the seven seas. Yet, within this past year, her mighty Peninsular & Oriental Steamship Company, the pioneer of the Orient, has dipped its flag to the flag of Japan. For half a century or more, the ships of the Peninsular & Oriental did a profitable business in the coasting trade in the Yellow and Japan Seas, back and forth from Japan to China, Korea, the Straits Settlements, India, and Australia, and thence by the Suez Canal to England. But to-day the directors of the Peninsular & Oriental admit that the Japanese new lines across and up and down the Yellow Sea can drive the Peninsular & Oriental out of the trade.

"Fifteen years ago there were hardly any Japanese trading ships afloat, except the little *sampans* that knocked about the coast, and the fishing fleets of open boats that toiled in the inlets. Japan, within the past twelve years, has put her vessels on the four great trade routes of the

world, to America, England, India, and Australia. In addition, she has nine distinct trade routes to the litoral of Asia, with vessels making trips under steam at least once a week. Every single one of the lines engaged in all the traffic gets a subsidy from the Government, the amount of it depending on the distance run and the tonnage of vessels."

To sum up the factors in the Pacific situation: the huge American fleet, of possibly 175,000 tons, handles the bulk of the freight either at a dead loss or at infinitely small profits; the tramp steamers, mostly British, are making the bare living that satisfies the tramp captain the world over; the subsidized Canadian Pacific fleet is supplied by ten thousand miles of good railroad and with "fast freight" from England by its Atlantic fleet; and the half dozen comparatively small and insignificant vessels of the Japanese fleet are making money all the time. The American and Canadian fleets are maintained largely through patriotism; the tramps and the Japanese fleet are there on business. In the end, unless conditions change, the two business factors will carry the entire Pacific trade.

THE ELECTROLYTIC PRODUCTION OF IRON SHEETS AND TUBES.

METHODS AND COST OF PRODUCING FINISHED SHEETS AND TUBES BY DIRECT ELECTRO-DEPOSITION FROM CRUDE IRON OR ORE.

Sherard O. Cowper-Coles—Iron and Steel Institute.

A REVIEW in these columns in the issue of THE ENGINEERING MAGAZINE for October described the process invented by Sherard O. Cowper-Coles for the direct electrolytic production of copper tubes, sheets and wire. Besides his investigations on the electro-deposition of copper, Mr. Cowper-Coles has for a number of years conducted researches on the electrolytic production of pure iron from crude iron or ore, and he has recently developed a commercial process for producing finished sheets and tubes in one operation. Some details of the results and cost of his process were given by him in a paper read before the Iron and Steel Institute at the recent Middlesbrough meeting, from which we quote at length.

Iron was first produced electrolytically in 1846. In 1851 the cost of the most successful process then available was in the neighobrhood of one shilling per pound, and Smee predicted that the electro-deposition of iron would never be commercially employed except for very limited applications. Up to the present the process has been confined to the facing of engraved copper plates for fine printing or to the production of solid iron electrotypes for bank note printing.

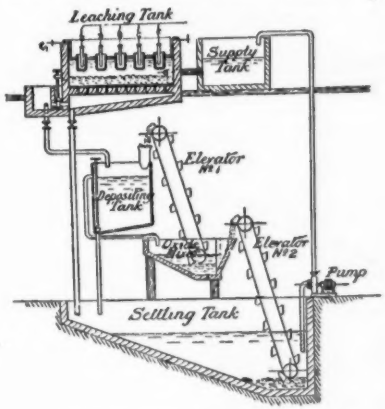
"The author, in the year 1898, made a number of experiments on the production of electrolytic iron plates, and produced plates of considerable thickness, but in such a rough condition that they required smelting and rolling; the rate of deposition, moreover, was so slow as to render the process impracticable, and it was not until the year 1900 that he succeeded in obtaining some small tubes. The results obtained were a great advance on what had hitherto been effected, but were not far enough advanced to be turned to practical account; it was not until the present year that sheets and tubes were obtained of a quality equal to steel, and with a surface that required no after-treatment, such as rolling or drawing.

"An electrolytic iron-production process, to be of commercial value, must fulfil the following conditions, namely, the voltage between the terminals of the depositing cell must be low, the current density per square foot of cathode surface must be high, and the iron or steel deposited must be in such a form that it can be used for industrial purposes without smelting. An electrolytic process that fulfils these conditions must revolutionise many branches of the iron trade, as it will enable thin iron tubes and sheets in particular to be produced at a

very low rate of cost and without the necessity of burning coal or carbon.

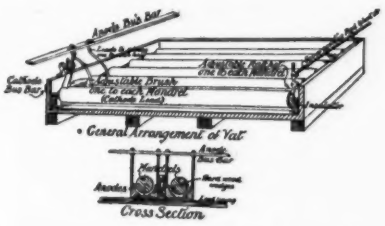
"The process briefly consists in placing crude iron (which may contain those elements which are at present so detrimental to the production of high-class iron or steel), or finely-divided iron ore, in suitable containing vessels in which an acid solution is circulated, using an insoluble anode material; or, further, the process may combine the use of soluble and insoluble anodes. The crude iron or iron ore being in each case connected to the positive pole of a dynamo, the iron goes into solution, and is deposited on cylinders or plates which may be either rotated or stationary, depending upon the class of finished product required.

"When crude iron is used, it is arranged around the cathode; insoluble ore is arranged around anodes, of graphite, for example, a small electric current being employed to assist the leaching process. It is conceivable that in some cases iron might be recovered without mining, acid liquor being circulated over the ore deposits. The process lends itself



GENERAL ARRANGEMENT OF PLANT.

to the recovery of iron, more especially from carbonated ores, 'blue billy,' lake, and bog ores. An electric process will no doubt also prove to be a valuable adjunct where pig-iron is used for precipitating copper, enabling the iron to be recovered instead of running to waste. Good results have been obtained from an ore containing:—Ferric oxide, 50.7 per cent.; lime, 3.8 per cent.; phosphoric acid, 1.51 per cent.; alumina, 10.0 per cent.; silica, 16.0 per cent. When it is desired to produce a highly finished sheet, a metal sheet of the desired surface is wrapped round the cathode, and held in position by means of grooves and wedges.



APPARATUS FOR THE DIRECT PRODUCTION OF TUBES.

"In this way sheets of large dimensions can be made, by employing a mandrel, say, 8 feet in diameter, a sheet 24 feet by 5 or 7 feet can be produced. When it is desired to produce tubes, iron mandrels somewhat smaller than the internal diameter of the finished tube are coated with lead by electro deposition, or by having lead drawn over them. Thus prepared, the mandrels are rotated in a special type of vat. When the desired thickness of iron has been deposited the mandrel is heated to a temperature sufficient to melt out the lead, and thus admit of its easy withdrawal.

"The electrolyte employed consists of a 20 per cent. solution of sulpho-cresylic acid saturated with iron. Sulpho-cresylic acid is a cresol-sulphonic acid containing approximately 108 parts of cresol and 98 parts of sulphuric acid. The cresol contains ortho, 35 per cent.; meta, 40 per cent.; and para, 25 per cent. This cresol is heated with sulphuric acid, yielding isometric cresol-sulphonic acids.

"In some cases it is advantageous to add small quantities of carbon-di-sulphide, the temperature of the solution being about 70 degrees C., the current density about 100 amperes per square foot. The solution is kept charged with iron oxide, which is kept in suspension in the

electrolyte by means of stirrers, by moving one or both of the electrodes, or by circulating by means of a bucket pump. The specific gravity of the electrolyte having the iron oxide in suspension is about 1.32.

"Excellent results have also been obtained by depositing the iron in a closed cell with a vacuum of a few inches, and also with a chloride solution and porous cells, bleaching powder being produced as a by-product; or the chlorine utilised to form fresh iron chloride.

"The following are two typical analyses of electrolytic iron produced under the conditions described in this paper:—(1.) Carbon (by combustion), 0.060 per cent.; silicon, 0.011 per cent.; sulphur, 0.016 per cent.; phosphorus, 0.041 per cent.; manganese, traces; arsenic, 0.004 per cent. (2.) Combined carbon, under 0.05 per cent.; silicon, 0.048 per cent.; sulphur, 0.045 per cent.; phosphorus, 0.04 per cent.; arsenic, 0.01 per cent.; manganese, traces.

"A peculiar feature of electro-deposited iron is that it creeps to an extraordinary degree with a rounded, smooth edge, over any material; in fact, it is difficult to stop its spreading. Under certain conditions, when employing a rotating cathode, long tentacles form, 6 inches or more in length, in the direction of rotation, with approximately the same curvature as the mandrel.

"Amongst other applications the process can be applied to the production of bi-metallic tubing and plates; that is to say, to tubes or sheets coated on the one side with copper or other metals or alloys.

"The process can also be applied to the direct production of large sheets or strips representing the cutting surface of a file, and cut up into portions of the desired shapes, and secured to suitable backing, to form separate files. The prints are produced by making a continuous impression or a number of impressions from a suitable die, revolving roller, or reciprocating tool in a lead alloy. The matrix thus prepared is mounted on a revolving drum, and steel deposited by the process which has already been described.

"Electrolytic steel, with considerable variation in the percentage of carbon, can also be produced. Houllevigue observed that when iron is deposited from iron containing uncombined carbon, the product at the cathode was free from carbon; but when deposited from iron containing combined carbon, the cathode product also contained carbon. The author's observations confirm this statement, and at a future date he hopes to publish figures showing the results that can be obtained. The amount of silicon in the iron can also be considerably varied. An important feature of the electrolytic process will no doubt be the introduction of some new ferrous alloys, which cannot be made by fusion. Alloys of iron and nickel have already been produced electrolytically.

"Electrolytic iron sheets can be obtained with a highly-finished surface, can be readily welded, coated with tin and zinc by dipping in a molten bath of these metals, coated with zinc by the Sherardising process, or electro-galvanised.

"The structure of electrolytic iron varies considerably, and in some cases it is found to be amorphous; whilst in other instances it possesses a structure somewhat similar to that of wrought iron."

The properties of electrolytic iron seem to depend largely on the amount of hydrogen present, and therefore on the annealing which reduces or eliminates the occluded hydrogen. Hydrogen is always present in quantities varying according to the conditions under which the iron is produced, in some cases amounting to 110 times the volume of the iron. The greater the hydrogen content, the harder the iron and the more powerful its magnetization. "There are two distinct varieties of electrolytic iron, with varying percentages of hydrogen: the softer kind of iron is silver-grey in colour, whilst the other variety is very hard and brittle, breaking as readily as glass, and containing a higher percentage of hydrogen. The hardness varies between these two extremes. A surface can be obtained on the latter of a silvery whiteness, and with a mirror finish with-

out polishing. Either quality can be produced at will by increasing or decreasing the electro-motive force at the terminals of the cell.

"Iron highly charged with hydrogen is very inert, and not readily attacked by acids. The softer quality is also comparatively inert. Equal surfaces of wrought iron and electrolytic iron were immersed in pure hydrochloric acid, 2 degrees Twaddell, for 18 hours. The electrolytic iron lost 2.48 per cent. of its weight, and the wrought iron 13.13 per cent. The temperature required for annealing electrolytic iron is slightly in excess of that required for ordinary rolled sheets. Electrolytic iron, when heated in a closed annealing-box, gives off large quantities of hydrogen; and if a pipe is fitted to the annealing-box the hydrogen flame can be kept burning during the whole process of annealing, and for a considerable time after the heat has been removed from the annealing box. This phenomenon has been turned to account for removing scale from ordinary rolled sheets by placing some sheets of electrolytic iron in an ordinary annealing-box with plates to be scaled. Electrolytic iron gives up considerable quantities of its hydrogen under 100 degrees C. without losing its brittleness, and also when boiled in water or oil."

Mr. Cowper-Coles estimates the cost of a plant to produce 5,000 tons of tubes, sheets and wire annually at 108,295*l.*, and the cost of productiou per pound of finished material 0.56*d.*

THE ECONOMY OF EXHAUST-STEAM TURBINES.

A RECORD OF INCREASED CAPACITY AND DECREASED COST IN TWO LARGE GENERATING STATIONS.

Charles B. Burleigh—National Association of Cotton Manufacturers.

THE low-pressure steam turbine was the subject of a long and valuable paper read by Mr. Charles B. Burleigh at the recent meeting of the National Association of Cotton Manufacturers. The most striking features of his discussion were an abstract of a report on the economic possibilities of low-pressure turbines, made to the Cambridge Electric Light Company by Prof. I. R. Hollis of Harvard, and a review of the remarkable results obtained in service by the Philadelphia Rapid Transit Company and the Scranton Street Railway. With Prof. Hollis' report we have not space to deal, but we present below a few data on service results taken from an abstract of Mr. Burleigh's paper in the *Electric Railway Journal* for October 10.

"The Philadelphia Company in 1905 installed at its Thirteenth and Mt. Vernon Street power station an 800-kilowatt Curtis low-pressure turbine. This station was equipped with four 1,500 horsepower and one 2,200 horse-power Wetherill Corliss engines, which had previously been operated non-condensing on account of the lack of cooling water. An Alberger condenser with 8,000 square feet of cooling surface was installed for use in connection with the low-pressure turbine. The rotary pumps for circulating the cooling water are direct connected to a 120 horse-power interpole motor, and the average vacuum obtained is 28 inches. The 1,500 horse-power engines are each direct connected to a generator which develops about 2,000 amperes at 575 volts. The turbine takes steam from a common exhaust main at a pressure of about one pound above the atmosphere. Exhaust steam from one engine when delivering 2,000 amperes is sufficient to deliver an output from the turbine of 1,300 amperes at 575 volts, with no increase in back pressure upon the engine. As about 150 amperes are required to operate the auxiliaries, the net gain from the turbine is from 1,000 to 1,200 amperes, or about 66⅔ per cent. As the gain from a condenser without the turbine would not exceed 25 per cent, the latter produces a net gain of 41⅔ per cent.

"The generator used with the turbine

is a six-pole direct-current machine, making 1,200 revolutions per minute, but the set is not fitted with a governor. With the turbine taking steam at atmospheric pressure, with 2-inches absolute back pressure in the condenser, the guaranteed water rate is 36 pounds per kilowatt-hour at full load. If the engine-driven generators tend to take more than their share of the load, the engine governors admit an additional volume of steam to produce the necessary energy, and the engines in turn deliver more steam to the turbine, tending to speed it up, and thus raise its voltage to effect automatic regulation.

"As the load conditions demanded a further increase in capacity, a second 800-kilowatt unit of the low-pressure type was installed in 1906 under similar conditions, with condenser and cooling tower. All the auxiliaries required in the turbine installation are motor driven, with the exception of two dry-air pumps, one step-bearing pump and two discharge pumps, the exhaust from which is utilized for heating the feed water, and the power to operate them is about 14 per cent of the turbine output. The two turbines are run about 18 hours per day. The coal consumption for all purposes at this station was 4.48 pounds per kilowatt-hour the first six months of 1905, before the turbines were installed. The coal consumption for all purposes after the turbines were placed in operation was, for the first six months of 1906, 4.08 pounds per kilowatt-hour. This meant a saving of $24,414 per year in fuel cost with coal at $3 per ton. It is figured that when further increase is needed additonal low-pressure turbines will cut down the coal consumption of the engines to at least 3 pounds per kilowatt-hour, and pay a good return on the investment.

"Looking at this plant from the first-cost side, the original steam equipment cost about $100 per kilowatt, and to have increased the capacity on the original lines would have required an investment proportional to the original outlay. The low-pressure turbines, however, were installed at an expense of approximately $50 per kilowatt, and as the turbines were utilizing the energy of the steam previously unused, the fuel consumption was not increased a pound, 2,300 kilowatts being made available at no more expense as regards fuel and attendance than was previously necessary to deliver 1,500 kilowatts to the distributing mains. During the year 1904 the engines were operated alone under normal conditions with the following results:

Average kilowatt-hour output per month	2,475,000
Average cost per kilowatt-hour.....	7.3 mills
Average cost of coal per kilowatt hour.	5.15 "
Average pounds of coal per kilowatt-hr.	4.6

"These conditions prevailed until January, 1905, when the first 800-kilowatt low-pressure turbine was placed in operation, and the conditions for the next year were as follows:

Average kilowatt-hours per month.....	2,500,000
Average cost per kilowatt-hour.....	6.9 mills
Average cost of coal per kilowatt-hour.	4.97 "
Average pounds of coal per kilowatt-hr.	4.47

"The addition of the low-pressure turbine, amounting to an increase of about 10 per cent in station capacity, delivering 10 per cent increased average power, used less coal to the extent of 105 short tons per month, or, in other words, an expenditure of $40,000 enabled the purchaser to deliver 25,000 kilowatt-hours more per month and save 105 tons of fuel. In January, 1906, the second low-pressure turbine was installed. The following were the conditions:

Average kilowatt-hour output per month	2,957,500
Average cost per kilowatt-hour.....	6.03 mills
Average cost of coal per kilowatt-hour.	4.5 "
Average pounds of coal per kilowatt-hr.	4.08

"During the year from 1906-7 the turbine averaged to carry 16.8 per cent of the load.

"Comparing the conditions during the year 1906, with the two turbines in operation, carrying but 16.8 per cent of the load, with the year 1904, before the turbines were installed, it was found that the station delivered an increased average amount of power to the extent of 19.5 per cent, or 482,500 kilowatt-hours per month, and that the total cost of the station output for the year 1904, with the engines, was $216,810, while the total cost for the year 1906, with engines and turbines delivering 5,790,000 kilowatt-hours more than in 1904, was $214,005. It thus cost $2,805 less to deliver 19.5

per cent more energy, incident to the low-pressure installation.

"The Scranton Street Railway was equipped with four simple non-condensing Corliss engines, of the following dimensions and capacities:

	Rated horse power.	Kilowatts.
No. 1. Allis, 42 x 54 in., 97 r.p.m....	1,400	1,000
No. 2. Dickson, 26 x 48 in., 80 r.p.m..	400	300
No. 3. Cooper, 26 x 48 in., 80 r.p.m...	400	300
No. 4. Cooper, 30 x 38 in., 97 r.p.m...	750	500
	2,950	2,100

"The engines were operated at an initial pressure of 115 pounds. Nos. 1 and 4 were direct connected, and the others were belted to individual generators of the capacity named. The average output of this plant is 1,500 kilowatts while the maximum requirements of short duration taxed the entire plant to its utmost. The exhaust of these four engines led down into a common tee, from the top side of which emerges a 30-inch free outlet to the atmosphere.

"Early in 1906 a 500-kilowatt Curtis low-pressure turbine was installed, taking steam through a 14-inch pipe connected to the 30-inch outlet, and exhausting through a condenser supplied with cooling water from the Lackawanna River, a distance of 450 feet, with a lift of 54 feet to the condenser head, at mean height of the river. The turbine, therefore, works between atmospheric pressure and 28-inch vacuum at a water rate of about 38 pounds per kilowatt-hour, or less than 20,000 pounds of steam per hour at its full rated capacity, while the engines, aggregating about 3,000 horse power will, at 30 pounds per horse power, exhaust, when working at their rated capacity, 90,000 pounds in the same time. There is, therefore, an opportunity here for the installation of at least two or three similar low-pressure units as soon as the load conditions warrant. The method of using the turbine output is similar to that practised in Philadelphia."

THE METALLOGRAPHIC STUDY OF ORE DEPOSITS.

EXAMPLES OF THE APPLICATION OF THE METHODS OF MICROSCOPIC METALLOGRAPHY TO THE STUDY OF COMPLEX ORES.

Dr. William Campbell—Canadian Mining Institute.

A LONG paper on the engineering applications of metallography, read last March before the Canadian Mining Institute by Dr. William Campbell, has just been published in the *Journal* of the Institute. With Dr. Campbell's discussion of the industrial applications of metallography, to which the larger part of his paper is devoted, we do not propose to deal. This subject will be exhaustively treated by M. Jacques Boyer in our next issue. We give below, however, a few examples of the application of the methods of microscopic metallography to the study of ore deposits, taken from the concluding section of Dr. Campbell's paper.

"The latest development of metallography is its application to economic geology. By its aid we can distinguish the relative ages of the various opaque constituents of ore bodies much more easily than can be done by hand specimens or in the petrographic slide, when dealing with complex and compact masses.

"The ordinary specimens from Butte, Mont., are composed of iron-pyrites with more or less copper. Under the microscope the pyrite is clearly the oldest constituent. It has been broken and fractured and then eroded by solutions. Then in the interstitial spaces were deposited bornite and chalcocite. The chalcocite is apparently younger than the bornite for it cuts it in places. Very often when the specimen shows chalcopyrite this latter was the last to form because it is the groundmass of the pyrite, bornite and chalcocite.

"The silver deposits of Cobalt, Ont., have been studied in this way. We find that the first mineral to crystallize out in the vein was smaltite and this was fol-

lowed by niccolite, for cubes of smaltite are found embedded in niccolite. Both the niccolite and the smaltite show signs of disturbance and are cut by veins of calcite. In a section from the La Rose mine rough smaltite is seen enclosed in smooth-polishing niccolite, both of which are cut by thin veins of calcite which appears black on account of the vertical illumination. Of later age still is the argentite which cuts the calcite; while the silver cuts both argentite and calcite. The bismuth came down with or a little later than the native silver. Thus we can establish the order: smaltite, niccolite, period of disturbance, calcite, then argentite, native silver and bismuth. In addition we find crystals of cobaltite incrusted on the rosettes of smaltite (cloanthite) embedded in the calcite, therefore, the cobaltite is slightly younger than the smaltite and older than the calcite. Mispickel occurs like cobaltite. It is well known that much of the silver in the Cobalt deposits is not pure. This is explained when it occurs as veins, for each vein has a thin envelope of a bluish harder substance which polishes somewhat in relief, probably a native alloy of silver.

"Nickeliferous pyrrhotites have long been the subject of discussion. Many hold that the nickel replaces the iron isomorphously. We have examined specimens from widely different localities and in each case the nickel occurred as pentlandite. Chalcopyrite usually occurs also and we find the following order of succession holds good: pyrrhotite, pentlandite, chalcopyrite. Secondly, their origin is much discussed. Are the deposits of direct igneous origin or have they been deposited through the agency of solutions? The specimens we have examined show such a structure that they could not have separated from an igneous mass. They show no resemblance to nickel mattes.

"The processes of decomposition and of secondary enrichment can be studied metallographically. . . . Another important line of work is the study of certain complex mineral species to determine their constitution. We can ascertain in many cases whether a mineral owes its peculiarity of formula to a definite combination or to the presence of foreign bodies as in the case of a mechanical mixture. In the majority of specimens examined there is found more or less admixture of foreign matter. Chalcopyrite includes chalcocite or pyrite, sometimes even galena. Tetrahedrite includes quite a number of other minerals and so on. Steel galena when examined is found in many cases to owe its fine structure to the presence of a second mineral. Each grain is surrounded by a fine film of quartz in one case, calcite in another, tetrahedrite in another, blende in another and so on. In many cases the galena was deposited, then crushed and the second constituent then deposited. Minerals often show the effects of strain when etched, especially galena and pyrrhotite."

THE UTILIZATION OF WASTE FURNACE GASES.

THE ECONOMY OF CO-OPERATION BETWEEN COKE-OVEN AND IRON-WORKS OWNERS AND ELECTRIC-POWER COMPANIES.

Charles H. Merz—Iron and Steel Institute.

IN the course of a long paper on electric power supply, with a special reference to its effect on the iron industries of the North-East Coast of England, presented before the Iron and Steel Institute at the Middlesbrough meeting, Mr. Charles H. Merz discussed in its economic aspects the problem of the utilization of waste furnace gases. We have from time to time referred in these columns and in leading articles to the various proposals for applying the waste heat of blast furnaces and coke ovens to the production of power, the last occasion being in our issue for December, 1907, when we reviewed Mr. B. H. Thwaite's pooling scheme. The method proposed by Mr. Merz, however,

contains elements of difference from any advocated hitherto, since he believes that the most efficient means of utilization is to be found in co-operation with regularly established electric-power companies.

"The problem is one of great moment, and, however dealt with, will involve years of work before a complete solution can be achieved. It is, therefore, the more important that the efforts directed towards such a solution should proceed on a commercially sound basis and along correct engineering lines. On a rigorous analysis of the situation it will be found that financial and other practical considerations definitely limit the pace at which progress can be made, and, especially in the case of blast-furnaces, greatly reduce the amount of power immediately available.

"Many engineers, fascinated by the magnitude of the figures, have proceeded to calculate the commercial value of the gas; the more cautious of them by estimating the total heat units contained in the gas, and then calculating the value of the coal necessary to give the same heat units; others by first assuming the gas is utilized in gas engines, and then calculating the tonnage and value of the coal required to produce the same horse-power from steam-engines. The second method gives a result twice as great as the first, which is itself already much too high, having left out of account the fact that the gas or heat in question can only be regarded as of the same value as coal if it can be utilised as cheaply from a capital expenditure point of view, if it can be stored as conveniently, and if it be available where and when required; in short, the commercial value of these waste products bears no direct relation to their value arrived at by either of the above methods.

"Dealing first with the waste energy from coke-ovens, each separate group of ovens usually consists of between 40 and 120 ovens, rarely exceeding the latter figure. The batteries of ovens are widely scattered and are, for the most part, at relatively long distances from the populous centres—that is to say, from the centres of power demand. The gas might be piped to some central point, as is the practice followed in America with natural gas, which is transmitted in some cases 200 miles; but this natural gas has twice the calorific value of coke-oven gas, and it is usually available at a pressure of 50 pounds per square inch or upwards, rendering it practicable to transmit a large volume of energy through a relatively small pipe, whereas to transmit coke-oven gas any distance there would have to be installed an expensive compressing plant. Further, there is, in addition to the gas given off from the coke-ovens, a certain quantity of waste heat which can only be utilised locally under boilers; and in no calculations which the author has made has he been able to establish a case for the transmission of gas for power purposes as against the alternative of converting the gas into electricity and transmitting the power in this form. Admitting the desirability of converting the gas into electricity, the doubtful point then remaining is whether it is cheaper for an owner of coke-ovens to put down his own generating station and to utilise the electricity so produced for his mines; or, alternatively, to co-operate with a power company, which he can do either by selling them the whole of the gas and purchasing in return what electricity he needs; or by undertaking to provide a portion of the capital required for generating-stations, which, when erected, would be operated by the power company, and the profits shared between the parties.

"In all cases investigated by the author it has been found that a greater profit will accrue to the coke-oven owner by co-operating with a power company than by proceeding on independent lines. There are three reasons for this:—

1. When a private owner erects a generating plant independently he must install some reserve or spare plant, with a consequent heavier outlay of capital than is necessary to a power company, which, possessing a coal-fired station, need install no spare plant in any of their waste-heat stations, but can, instead, meet any variation of load by the

coal-fired station, which also acts as a stand-by against any breakdown.

2. This necessity of putting down spare plant results in smaller, and therefore more expensive and less efficient plant. To take a case—supposing 2000 horse-power is available, if the station is to be used in conjunction with the power company's system—one 2000-horse-power unit would be entirely satisfactory, the power system acting as stand-by. If it is to be used in a separate generating-station, one would probably install three 1000-horse-power units, two working and one spare. The gain in the former case in capital cost, running cost, and efficiency is obvious. As a matter of fact, the capital cost in the second case would be nearly double what it would be in the first.

3. The power company, having a market for current many times greater than the output of any individual waste-heat station, can run such a station continuously at maximum output, so utilising completely all the current that can be produced; whereas it is impossible to conceive the power requirements of an individual coke-oven and colliery-owner coinciding even approximately over twenty-four hours with the amount of gas or waste heat available. . . . .

"It is more difficult to reach a decision in the case of blast-furnaces, as the conditions vary so widely. Of course, if a company produces pig iron only, and does not convert the iron into steel, co-operation with a power company is at present, practically speaking, the only outlet which it has for its surplus power. If, however, a blast-furnace works has a steel mill attached, it may be argued that the correct thing to do is to follow the plan adopted by many large works in Germany—namely, to install gas-engine blowers and gas-driven dynamos at the blast-furnaces, the latter plant producing the necessary power for driving the steel mills.

"In the case of the new works which the United States Steel Corporation are putting up at Gary, they are arranging to drive the whole of their steel-works electrically, and they reckon to get all the power required for the steel mills from the blast-furnace gas utilised in gas-engines, of which they are installing 27,000 horse-power; but—and this is an important consideration—they are putting down, to act as a spare to the gas-engines, steam plant, the boilers supplying which can be coal-fired. The resultant capital cost per useful horse-power of plant is therefore great, probably at least twice as much as it would have been had it been possible there to co-operate with a power supply company.

"Capital charges are invariably the controlling factor in the total cost of electricity, and the question raised above—namely, whether it is commercially sound for a blast-furnace owner to co-operate with a power company or not—can only be decided in each individual case after full consideration of the capital outlay involved, the amount of spare plant that has to be provided, and the degree of coincidence between supply and demand. It is clear that if it be decided to make the works self-contained, then the supply capacity must always be in excess of the possible demand, otherwise a risk is run of a portion of the works having to be stopped, and as the demand varies from time to time there must be a variable amount of gas utilised involving wastage when supply exceeds demand, or the burning of coal at certain periods when demand exceeds supply. Given an equitable arrangement, it is clear that the same general arguments in favour of co-operation which hold in the case of coke-ovens are applicable to blast-furnaces with steel works attached.

"As illustrating one aspect of the case, I quote from an article on the German Steel-Works Union, published in the Financial and Commercial Supplement to the *Times*, dated July 3, 1908: 'The latter concerns (the German iron and steel works) have grown up under the economic impulse to find and employ the cheapest method of production in order to secure iron at the lowest possible cost. They have erected blast-furnaces around their mills. . . . The gases formerly escaping from their furnaces and going to waste now supply a cheap

motive power for their steel and rolling-mills. They make their own coke, and the coking process furnishes valuable by-products besides supplying, in many cases, an additional source of fuel-gas for the power plants.'

"Later on, in speaking of the big iron producers who form the Dusseldorf Syndicate, the writer says that in spite of dull trade 'the great works continue to smelt iron at almost the pace they set when the recent wave of prosperity was at its height. The economies involved in the situation almost compel them to do so. To a considerable extent they have long-term contracts for foreign ores for mixing with home ores; their coking-ovens must continue in operation for the sake of the by-products, and the coke produced would deteriorate in quality if stored. But more than this, the furnace gases are needed for driving their steel-mills, and it is often difficult to blow out a furnace or two without seriously disturbing the power supply.'

"It would therefore appear that even after a rough approximate balance has been secured between supply and demand it is readily upset by ordinary market fluctuations. The natural variation of trade thus furnishes a further argument in favour of the co-operative principle in the utilization of blast-furnace and coke-oven gases.

"The power companies in this district having their transmission cables interlacing the entire industrial area, and being in a position, with their large load already developed, to utilise any amount of electricity whenever and wherever produced, are arranging for waste-heat stations at different points, turning all the electricity so produced into a common network from which the colliery company, the coke-oven owner, or the blast-furnace owner can purchase any amount he may require, all spare plant and all plant to deal with exceptional peak loads being kept at the main central coal-fired station. Such a policy applied to other commodities is as old as the hills; it began in the most primitive market when a producer gave his raw material and received in exchange manufactured articles, but so far as the author is aware this is the first time it has been extensively applied to electricity, although the principle so applied is equally sound, and it appears that only in this way is it possible to conserve the full national value of the energy now being wasted."

THE ELMORE VACUUM PROCESS.

PRACTICAL NOTES ON THE OPERATION OF THE PROCESS IN THE CONCENTRATION OF SULPHIDE ORES.

R. Störcn—The Engineering and Mining Journal.

ON another page of this issue of THE ENGINEERING MAGAZINE Mr. Chas. C. Christensen describes in brief outline the Elmore vacuum process of ore concentration. We supplement here Mr. Christensen's necessarily brief note with a few paragraphs on the practical operation of the process, taken from a lengthy paper by Mr. R. Stören in *The Engineering and Mining Journal* for October 31.

"The size of the particles is of great importance in the operation, for it greatly affects the results obtained. The fineness to which the ore should be crushed depends upon the size and distribution of the mineral particles, a maximum of purely metallic mineral particles being the aim, or rather a minimum of middlings containing both metallic and non-metallic minerals in the same particle. There is a maximum and minimum size, between which ore is suitable for concentration by the oil-acid process. Classification may be advantageous, but it is not necessary except for removing the more plastic slime-forming material. The size of the particles ought not to exceed 20-mesh, or about 1 millimetre. Ten-mesh material has been tried, but particles of this size do not adhere readily to bubbles.

"The water supply must be in proportion to the size of the ore. The larger

the particles the more water must be used in the feed pipe, to increase the velocity and to prevent lodging; this also increases the velocity in the concentrator and aids in holding the material in suspension. The settling of the tailings against the rising current limits the supply and the velocity of the feed water.

"The percentage of slime produced determines the degree of crushing permissible. The surface of the slime particles is very great in proportion to the volume. The fine material is easily brought into suspension, and long remains in that state. Still finer slime has a plastic consistence, which has an important effect upon the working of the process. When the volume of the minute slime particles approaches zero, the area must also approach zero; and the body which has practically no surface cannot adhere to anything. The finest slime, therefore, cannot be enriched by means of the adhesion process. The addition of acid, as already explained, has some regulative effect; but the finest slime, chiefly the pyrite particles not wetted by contact with oil in the mixer, passes into the concentrator, and by means of its plastic consistence hinders separation in the central region of the cone. This fine plastic material should, therefore, be removed before the ore enters the mixer. For this purpose a thickening tank has been employed.

"The pyrite slime which carries gold and silver may contain a higher proportion of those metals than the original ore. Tests on a Norwegian ore gave the following results:

	Copper, Per Cent.	Silver Grams per Ton.	Gold Grams per Ton.
Original ore	1.56	10	1
Slime	1.79	18	2

"An explanation of this phenomenon may be found in the mode in which the precious metals occur in the pyrite, as microscopical particles, often upon the surface of the crystals and between the pyrite particles and the inclosing rock minerals. The statement made by certain eminent authorities that the precious metals are bound to the sulphides, cannot be accepted without question. During the crushing a relatively large proportion of precious minerals will detach from the pyrite and, because of their extreme fineness and high specific gravity, partly pass into the slime, and partly into the tailings. The detached gold may be without bright surfaces, the so-called black gold, similar to that formed by the reduction of gold from a solution.

"The crystalline form of the minerals may play a rather important part in ore dressing by the adhesion process. The mode of crystallization may be divided into two types: Forms which produce numerous planes, such as prismatic and tabular crystals; and the more globular forms, polyhedrons, etc. The form may be of considerable importance when the individual crystals are small enough to pass 30- to 40-mesh screens; and also the cleavage planes of such minerals as molybdenite and mica.

"Although the so-called oil process was first brought into practical prominence by the introduction of the Elmore vacuum concentrator, the vacuum chamber is not the chief feature of the apparatus; the mixer remains the fundamental factor in the process. Errors made in the mixer, in crushing, in the addition of acid and oil, cannot be remedied in the concentrator. It would be quite as sensible to try to correct the mistake of feeding unclassified material to Wilfley tables by regulating the supply of water. It is, therefore, necessary to examine the ores carefully to determine the properties of their constituent minerals, which may require more or less adjustment in the mixer to obtain the best possible result in the concentrator.

"As stated before, the effect of the acid is chemical; it removes the weathered surface of the mineral. According to Elmore, mine water with acid reaction may be used instead of the dilute sulphuric acid. Ores with oxidized surfaces require more acid in the mixer than ores with fresh surfaces.

"Ore from a Norwegian mine which had been stored for some time and had become weathered, was treated with 0.45 per cent. raw petroleum and 0.9 per cent. acid, and concentrated in an Elmore apparatus. The ore before treatment contained 1.15 per cent. copper and

6.89 per cent. sulphur. The extraction of copper was 56 per cent. and sulphur 46 per cent. The same ore crushed and screened through 35-mesh, and treated with the same quantity of acid and oil yielded an extraction of 75 per cent. copper and 76 per cent. sulphur. The better extraction was due to the fresh fracture planes produced during crushing.

"A Swedish ore, also weathered, and containing 1.18 per cent. copper, 1.76 per cent. sulphur, and about 25 per cent. magnetite, after treatment with 0.8 per cent. Texas oil and 0.3 per cent. acid, yielded in the Elmore apparatus, an extraction of copper 65 per cent, and sulphur 15 per cent. Fresh ore from the same mine, with the same percentage of minerals and mixed with the same quantities of oil and acid, gave an extraction of 79 per cent. copper and 25 per cent. sulphur.

"Chalcopyrite resists surface oxidation better than iron pyrite; the latter requires more acid in the mixer, even when the surfaces are rather fresh. The presence of magnetite in large proportions causes low extraction of iron pyrite, for it neutralizes the acid leaving the particles of pyrite covered with a coating of amorphous oxide. In this case it is better to remove the magnetite by means of magnetic separation before treatment by the Elmore process.

"In the regular operation of the process it has been remarked that ores with pyrites oxidized on the surface are concentrated by acid as much as by oil. The gas bubbles, formed during the solution of the coating, adhere to the cleaned surface and float the particles with the expenditure of less oil than in the case of fresh pyrites. It may be said, that chalcopyrite is separated by means of oil; iron pyrite, by means of acid. It is important that the agitation in the mixer be not so violent as to destroy the gas bubbles formed on the pyrite particles by the acid.

"The treatment of bornite in the mixer should be similar to that outlined for pyrite ores. Bornite belongs to that class of minerals which, when exposed to the air, are soon covered with a coating. A larger proportion of acid is required than for chalcopyrite and, as in the case of iron pyrite, bornite ore is best treated when fresh. By using more acid and warm water in the mixer, bornite ore should give as good extraction as chalcopyrite.

"Concerning the quantity of oil to be used, it may be said in general that a minimum of oil gives a clean concentrate, but also rich tailings. This is, of course, due to the fact that the cleanest pyrite particles have better adhesion to the oil foam than the particles which contain gangue minerals. If a large proportion of oil is used, the middlings will begin to float, and, after still greater additions of oil, some rock minerals, chiefly mica, enter the tailings as well as magnetite and hematite.

"The use of warm water in the mixer aids the action of the acid; it also increases the tendency of oils to foam. Heating the water for the feed pipe of the concentrator outside the mixer is, however, not to be recommended, for heat causes the emission of more or less of the absorbed air, and this air furnishes bubbles required in the concentrator."

RECENT RESULTS WITH THE STASSANO ELECTRIC FURNACE.

DATA OF POWER CONSUMPTION IN THE PRODUCTION OF STEEL FROM THE ORE AND FROM SCRAP, SPECIAL STEELS AND SPECIAL ALLOYS.

M. Stassano—Revue de Métallurgie.

SOME interesting results of Stassano electric-furnace operation at the Turin arsenal and the works of the Société Forni Thermoelettrici Stassano at Turin are given in a long paper by M. Stassano in the *Revue de Métallurgie* for September. Besides reporting the results of recent tests, M. Stassano goes into a long discussion of the general subject of the electrometallurgy of iron and steel and of the design and merits of his furnace, which space will not permit us

to reproduce. We present below a few data on power consumption in the production of steel direct from ore and from scrap, special steels and special alloys, taken from M. Stassano's detailed tables.

The general design of the Stassano furnace is well known. It will be remembered that it is of the vertical cylindrical type, the heat being produced by an arc between carbon electrodes projecting through the walls above the charge. The latest furnaces designed by Stassano rotate upon a circular rail placed on an inclined plane, to secure thorough mixing of the charge. A 200 horse-power furnace was built in 1903 at the Turin arsenal for making projectile steel and more recently there have been installed in the works of the Société Forni Thermoelettrici Stassano in the same city two fixed 100 horse-power furnaces, one rotating 200 horse-power furnace, one tilting 200 horse-power furnace, and two 1,000 horse-power furnaces, one fixed and one rotating; and at the works of the Bonner Froeserfabrik at Bonn, a 250 horse-power revolving furnace.

In the four tests on direct ore reduction, of which M. Stassano gives the results, the charges consisted of 1,000 kilogrammes of ore containing oxide of iron, 68.70 per cent; oxide of manganese, 3.22 per cent; silica, 17.15 per cent; alumina, 2.0 per cent; lime, 1.0 per cent; magnesia, 5.67 per cent; phosphorus, 0.15 per cent; and sulphur, 0.12 per cent; together with 350 kilogrammes of limestone, 240 kilogrammes of charcoal, 80 kilogrammes of an aqueous solution of silicate of soda, and 50 kilogrammes of calcium carbide. The products of the four heats had the following analyses, the variation in the last being due to recarburization by the addition of some hematite pig iron:

	1.	2.	3.	4.
Carbon	0.25	0.26	0.30	0.80
Manganese	0.12	0.21	0.24	0.30
Silicon	0.07	0.03	0.14	0.22
Phosphorus	0.01	0.01	0.015	0.015
Sulphur	0.065	0.04	0.07	0.045

Power consumption in these four cases was, respectively, 4.5, 4.3, 4.0 and 4.2 kilowatt-hours per kilogramme of product. The steel produced in the second and third heats showed a tensile strength of 55 kilogrammes per square millimetre and an elongation of 23 per cent. In the fourth heat these values were changed to 86.3 kilogrammes and 13 per cent respectively.

A large amount of work has been done in the production of soft steel castings from scrap material. Analyses of the products of six heats using the same weight and composition of charge in each case follow:

No	C.	Si.	S.	P.	Mn.
1	0.20	0.33	0.050	0.038	1.02
2	0.22	0.10	0.045	0.030	0.42
3	0.22	0.17	0.052	0.026	0.50
4	0.26	0.09	0.048	0.025	0.49
5	0.26	0.28	0.040	0.035	0.44
6	0.25	0.20	0.050	0.035	0.41

The castings produced had an average tensile strength of about 42 kilogrammes per square millimetre and showed an average elongation of about 18 per cent. Power consumption for this class of work averaged over the whole of 1907 1.26 kilowatt-hours per kilogramme of metal. The production of projectile steel from scrap at the Turin arsenal takes about the same amount of power.

Special tungsten alloys containing from 58 to 69.7 per cent tungsten have been obtained for an expenditure of power of 6 to 7.5 kilowatt-hours per kilogramme. The power consumption in the production of silico-manganese with approximately 60 per cent manganese and 20 per cent silicon was 7.4 kilowatt-hours per kilogramme. Very satisfactory results have been obtained also in the manufacture of special steels, a product of the desired composition being obtained with very little difficulty.

M. Stassano gives the consumption of the electrodes at 10 kilogrammes per ton of steel produced and the cost of furnace lining at 10 francs per ton except in very exceptional cases. The labor necessary to operate a furnace up to 300 horse-power capacity is three men. For a 1,000 horse-power furnace four men are required when using liquid metal or ore, and five or at most six when using cold stock.

THE ENGINEERING INDEX

"THE KEYSTONE IN·THE·ARCH·OF·APPLIED·SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Cantilever.

The Sydney Harbor Bridge, New South Wales. C. O. Burge. Describes approved designs for a proposed bridge to North Sydney with a main cantilever span of 1,350 ft. and a minimum headway of 170 ft. at the centre. 3200 w. Eng Rec—Oct. 10, 1908. No. 95742.

Columns.

Nickel Steel for Bridges. Editorial review of a recent paper by A. J. Waddell. 2000 w. Engng—Oct. 16, 1908. No. 96055 A.

Concrete.

Moving Loads on Concrete Bridges. Daniel B. Luten. The advantage of the low ratio of live load to fixed load. 600 w. R R Age Gaz—Oct. 30, 1908. No. 96237.

Culverts.

See Reinforced Concrete, under BRIDGES.

Drawbridges.

An Effective Drawbridge Compensation. A. D. Cloud. Account of method to facilitate the working of bridge couplers. 1500 w. Sig Engr—Sept., 1908. No. 95817.

We supply copies of these articles. See page 579.

Erection Travelers.
See Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Failures.
Fall of the B. & O. Susquehanna Bridge. William Allen. Description of the failure of the falsework and temporary span. Illus. 1000 w. Sci Am—Oct. 10, 1908. No. 95691.

Girders.
Riveting for Built-up Girders. Mathematical study, illustrated by example. 1500 w. Am Mach—Vol. 31, No. 44. No. 96209.

Masonry.
The Masonry Arch Bridge Across the Connecticut River at Hartford. Illustrated description of a fine example of this type. 1200 w. Eng News—Oct. 22, 1908. No. 96012.

Quebec.
See Testing Materials, under MEASUREMENT.

Reinforced Concrete.
Reinforced Concrete Highway Bridges and Culverts. Owen McKay. From Pro. Assn. of Ontario Land Surveyors. Plans and descriptions of bridges and culverts constructed in 1907. 2000 w. Can Engr—Oct. 16, 1908. No. 95907.

A Combined Concrete and Steel Girder Bridge, Monroe St., Brookland, D. C. W. J. Douglas, and W. P. Darwin. Illustrated description of a somewhat unusual type. 1500 w. Eng News—Oct. 29, 1908. No. 96218.

Bridge Reconstruction on Columbus and Lake Michigan Railway. Dan'l B. Luten. Description of reinforced concrete bridges replacing wooden trestles and truss bridges built while maintaining traffic. 1800 w. Elec Ry Jour—Oct. 3, 1908. No. 95592.

Steel.
Statistics as to the Life of Steel Railway Bridges. Discusses life of 10 American railway bridges. 1000 w. Engng-Contr—Oct. 7, 1908. No. 95731.

Data on 14 Steel Bridges (Highway and Railway) Including Weights, Cost, etc. Discusses the weight of long span, swing and lift bridges. 2500 w. Engng-Contr—Oct. 7, 1908. No. 95730.

Replacing the Clyde River Bridge of the West Shore Railroad. Illustrated detailed description of work at Lyons, N. Y. 2500 w. Eng Rec—Oct. 24, 1908. No. 96035.

See also Failures, and Girders, under BRIDGES.

Suspension.
A Temporary Suspension Bridge. Illustrates and describes a footbridge with a span of 120 ft. in the town of Sulphur, Okla. 800 w. Eng Rec—Oct. 17, 1908. No. 95937.

Trestles.
Reinforced Concrete Trestle and Stone Bins. Account of combined trestle and stone bins into which is dumped crushed stone used in paving, Springfield, Mass. Ills. 850 w. Ry & Engng Rev—Oct. 10, 1908. No. 95807.

Viaducts.
The Harrison Avenue Viaduct at Cincinnati. Illustrated detailed description of this steel structure. 2200 w. Eng Rec—Oct. 17, 1908. No. 95931.

CONSTRUCTION.

Bins.
See Trestles, under BRIDGES.

Brick.
Bond in Brickwork. Ernest Alfred William Phillips. Gives results of practical experience, with diagrams. 3000 w. Inst of Civ Engrs—No. 3652. No. 95-490 N.

Campanile.
The Campanile of St. Mark. Abstract translation from *Le Génie Civil*, giving a summary of the principal works of engineering interest involved in the reconstruction. Ills. 3000 w. Engr, Lond—Sept. 18, 1908. No. 95408 A.

Concrete.
See Conveyors, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Contracts.
Time Penalties on Contracts. J. A. King. Paper read before Am. Public Works Ass'n.; discusses legal aspects of various contracts. 9000 w. Eng Rec—Oct. 3, 1908. No. 95620.

Excavation.
The Value of Cost Keeping; a High Cost of Wheel Scraper Work and a Lesson. Discusses cost keeping in excavation and the advantages of comparing different methods of work. 1300 w. Engng-Contr—Sept. 30, 1908. No. 95582.

The Cost of Excavating Earth in Small Quantities with a Steam Shovel. Analysis of cost where less than 100 yds. daily was to be moved. 900 w. Engng-Contr—Oct. 7, 1908. No. 95726.

The Cost of Excavating Earth and Hauling in Small Steel Cars. Describes use of 1½ yard all steel cars on a 30-in. gage track for excavating and transporting earth. 800 w. Engng-Contr—Sept. 30, 1908. No. 95582.

Factories.
Concrete and Steel Workshop in Canada. Illustrated description of a factory building at Peterborough, Ontario. 1400 w. Engr, Lond—Oct. 9, 1908. No. 95-994 A.

Foundations.
Building the Foundations of the Grau du Roi Station Buildings on "Simplex" Piles (Notice sur l'Exécution des Fondations des Bâtiments de la Gare du Grau

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du Roi sur "Pilotis Simplex"). M. Colombaud. Illustrated description of the work of preparing the foundations of a number of large buildings. 3800 w. Rev Gen des Chemins de Fer—Sept., 1908. No. 96111 G.

Gas Holders.

Raising and Supporting a Gas Holder. W. R. Phillips. Describes the renewing of the foundation of a large gas holder and the straightening of the tank. Illus. 3300 w. Eng Rec—Oct. 3, 1908. No. 95619.

Piling.

See Cofferdams, under WATERWAYS AND HARBORS.

Reinforced Concrete.

Reinforced Concrete and Its Practical Application. M. Kahn. Illustrated account of features of British practice with discussion. 12000 w. Trans Int Eng & Ship in Scot—Vol. 51, Feb. 18, 1908. No. 95608 N.

Reinforced Concrete. J. Monash. Read before the Roy. Victorian Inst. of Archts. Considers the factors upon which the economy of modern concrete construction depends. 2500 w. Surveyor—Sept. 18, 1908. No. 95436 A.

Reinforced Concrete Construction by the Works Construction Force. Warren H. Miller. Discussion of costs and methods including mixtures to be used. Ills. 3500 w. Eng Rec—Oct. 10, 1908. No. 95739.

Approximate Formulæ for Reinforced-Concrete Design (Annäherungsformeln für Eisenbetonbauten). O. Domke. Mathematical examples of their derivation and application. Ills. Serial. 1st part. 2500 w. Beton u Eisen—Sept. 2, 1908. No. 96175 E.

Reinforced Concrete Warehouse at Tempelhof on the Teltow Canal (Eisenbeton-Speicher im Tempelhofer Hafen am Teltowkanal). Illustrated description of a large six-story building. Serial. 1st part. 1600 w. Beton u Eisen—Sept. 24, 1908. No. 96176 E.

See also Trestles, under BRIDGES; Well Sinking, under WATER SUPPLY; Gas Engine Foundations, under MECHANICAL ENGINEERING, COMBUSTION MOTORS; and Stamp Mills, under MINING AND METALLURGY, ORE DRESSING AND CONCENTRATION.

Steel Buildings.

The Fifth Avenue Building, New York. Illustrated description of the unusual features of design and construction of this steel-cage structure. 2200 w. Eng Rec—Oct. 17, 1908. No. 95929.

Tall Buildings.

The Tall Building Question. F. W. Fitzpatrick. Suggestions for avoiding the canyon-like streets and securing light and air, etc. 2000 w. Archt, Lond—Sept. 25, 1908. No. 95897 A.

Tunnels.

Construction of the St. Paul Pass Tunnel; Chicago, Milwaukee & St. Paul. Account of the construction of a tunnel 8,750 ft. long through the Bitter Root Mts. Ills. 1500 w. R R Age Gaz—Oct. 9, 1908. No. 95754.

Difficult Tunneling for Water Supply. H. R. Mason. Illustrates and describes a tunnel through solid limestone to provide a large power station with condensing water. 3500 w. Power—Oct. 20, 1908. No. 95971.

The Rotherhithe Tunnel Under the Thames, London (Le Tunnel de Rotherhithe, sous la Tamise, à Londres). Edmond Henry. Illustrated description of the method of construction. 4000 w. Génie Civil—Sept. 26, 1908. No. 96128 D.

Underpinning.

Permanent Underpinning for the Paris Subway of the Paris and Orleans Ry. Illustrated detailed description of this interesting work and the methods of carrying it out in the face of very heavy traffic. 1200 w. Eng News—Oct. 15, 1908. No. 95958.

Wind Pressure.

Experiments on Wind-Pressure. Thomas Ernest Stanton. An account of research work and results, describing methods. Also discussion. Diagrams. 18500 w. Inst of Civ Engrs, No. 36905—Dec. 3, 1907. No. 95494 N.

MATERIALS OF CONSTRUCTION.

Cement.

The Commercial Value of Fine Grinding of Portland Cement. Richard K. Meade. Gives results of experiments to determine commercial value of fine grinding. Abstract of paper read before the Am. Soc. for Testing Materials. 2800 w. Engng-Contr—Sept. 30, 1908. No. 95581.

Paints.

Painting Cement Surfaces. P. W. Nelson. A paper read before Ohio State Assn. of Master House Painters and Decorators. A practical discussion of methods and materials. 1000 w. Munic Engng—Oct., 1908. No. 95523.

Reinforced Concrete.

Tests on Reinforced Concrete Beams. E. Brown. Describes tests made at McGill University, of different methods of reinforcement, particularly the Kahn and Johnson bars. Ills. 3500 w. Can Soc of Civ Engrs—Oct. 15, 1908. No. 95463 N.

Tests of Reinforced-Concrete Columns (Versuche mit Säulen aus Beton-Eisen). Fritz von Emperger. Gives results of four tests on concrete-filled iron columns. Ills. 2500 w. Beton u Eisen—Sept. 2, 1908. No. 96174 E.

Steel.

Nickel Steel for Bridges. J. A. L. Waddell. A report of experimental investigations upon the comparative values

of nickel steel and carbon steel for bridge building and the results. Ills. 30000 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95484 E.

Timber Preservation.

The Open-Tank Method of Preserving Timber. Howard F. Weiss. Brief discussion of the history, theory, and application of the open-tank or non-pressure process. 2500 w. Elec Ry Jour—Oct. 17, 1908. No. 95926.

The Comparative Value of the Antiseptics Used in Timber Preservation (Valeur comparative des Antiseptiques employés pour la Préservation des Bois). E. Lemaire. Gives the results of researches on eight of the commonly employed impregnating materials. Ills. 4000 w. Génie Civil—Sept. 19, 1908. No. 96127 D.

See also same title, under MINING AND METALLURGY, MINING.

MEASUREMENT.

Cement Testing.

Portland Cement Testing. W. C. Reibling and L. A. Salinger. A discussion of modern cement specifications. 14000 w. Philippine Jour of Science—June, 1908. No. 96099 N.

Surveying.

Levelling of Precision on the Panama Canal. Abstract of a report by W. G. Comber describing work and results. 1400 w. Ry & Engng Rev—Oct. 10, 1908. No. 95808.

Bench Levelling for the Board of Water Supply, New York. Illustrated description of method used in a continuous level line from Schoharie Co., N. Y., to N. Y. City and Suffolk Co., Long Island. 6500 w. Eng Rec—Oct. 3, 1908. No. 95616.

Diurnal Atmospheric Variation in the Tropics, and Surveying with the Aneroid. Theodore Graham Gribble. 2000 w. Inst Civ Engrs—No. 3741. No. 95495 N.

Testing Laboratories.

The Testing Laboratory of the Detroit River Tunnel Company. Description of apparatus for testing materials employed in the construction. Illus. 1800 w. Eng Rec—Oct. 3, 1908. No. 95617.

Testing Materials.

Test of a Model of the Quebec Bridge. Illustrated description of test of model of the chord that failed on compression testing machine of the Phoenix Iron Co. 5500 w. R R Age Gaz—Oct. 2, 1908. No. 95565.

MUNICIPAL.

Abattoir.

A Municipal Abattoir in South Africa. R. A. Webster. Brief description of Krugersdorp municipal slaughter house, the first in South Africa, from the *Surveyor*. 1000 w. Munic Engng—Oct., 1908. No. 95527 C.

Garbage Disposal.

Garbage Collection and Disposal at Cleveland. W. J. Springborn. Illustrated description of plant for treating city garbage. 1800 w. Dom Engng—Oct. 3, 1908. No. 95703.

The New Refuse Destructor at West New Brighton, N. Y. Illustrated description of the plant with summary of official tests. 4400 w. Eng Rec—Oct. 3, 1908. No. 95621.

Richmond Borough Refuse Destructor. Report of J. T. Fetherston giving the latest information of this very important plant. Ills. 3000 w. Munic Jour & Engr—Sept. 30, 1908. No. 95477.

A 40-Ton Garbage Incinerator at Oak Park, Illinois. Describes a plant for a suburban town of about 20,000 population. Ills. 1400 w. Eng Rec—Oct. 10, 1908. No. 95737.

The Disposal and Utilization of Household Refuse (L'Evacuation et l'Utilisation des Ordures ménagères). P.-Aristide Bergès. Suggests an improved method of dealing with the garbage disposal problems of Paris. 3500 w. Génie Civil—Sept. 26, 1908. No. 96129 D.

Manholes.

Method and Cost of Constructing Wooden Form for Concrete Manholes. P. W. England. Illustrated description of a simple type. 500 w. Engng-Con—Oct. 28, 1908. No. 96233.

Parks.

Park Systems for Great Cities. H. V. Lanchester. Suggestions with special reference to London. Plans. 5000 w. Builder—Oct. 3, 1908. No. 95896 A.

Pavements.

Iron-Slag Block for Street Paving. Description of its use and qualities; extent used in American cities. Also editorial. 2200 w. Eng News—Oct. 8, 1908. No. 95749.

Roads.

More Concerning English Highways. The contrasts in conditions in England and the United States are discussed and points worthy of study by American engineers. 1500 w. Eng News—Oct. 15, 1908. No. 95960.

Road Construction Work by Grading Camp Maintained by County. Describes operations of a grading gang in Dallas Co., Iowa, working continuously. 900 w. Engng-Contr—Sept. 30, 1908. No. 95583.

Methods and Cost of Constructing Tar-Macadam, Tar-Pitch-Macadam and Tar-Asphalt-Macadam Roads in Rhode Island. 3700 w. Engng-Contr—Oct. 7, 1908. No. 95727.

The Maintenance of Macadam and Other Roads. Ira O. Baker. An informal discussion of facts and theories, difficulties, etc. Ills. 6500 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95486 E.

The Maintenance of Highways in View of the Advent of the Motor Vehicle. Clifford Richardson. Read at the Int. Roads Congress at Paris. The effect on macadam and gravel roads is especially considered, and the best ways yet found for meeting the problem. 4800 w. Eng Rec—Oct. 17, 1908. No. 95933.

The Effect of Automobiles on Macadam Roads. L. W. Page. Abstract of address of Director U. S. Office of Public Roads before Buffalo Legislative and Good Roads Convention. 2000 w. Munic Engng—Oct., 1908. No. 95532 C.

The Destructive Effect of an Automobile Race on Roads. Translation of a paper in the *Annales des Ponts et Chaussées* by M. Salle, engineer-in-chief of bridges and highways. Discusses damage to roads in the Department of Sarthe by the *Grand Prix* of 1906. 1700 w. Eng Rec—Oct. 10, 1908. No. 95734.

Road Improvements and Resurfacing Experiments. Harold A. Hosking. Extract from a report to the St. Germans Rural District Council in which the damage due to heavy and fast motor vehicles is discussed, as well as different binding materials. 3700 w. Surv—Oct. 2, 1908. No. 95884 A.

The Selection of Dust Preventives. Abstract of a monograph by Prevost Hubbard of the U. S. Office of Public Roads. 8000 w. Eng Rec—Oct. 3, 1908. No. 95618.

Surface Treatment of Roads with Reference to Dust Laying. Reginald Brown. Deals with methods of treating existing road surfaces for the prevention of dust. 2500 w. Jour Roy San Inst—Oct., 1908. No. 95898 B.

The Oiled Roads of Santa Monica, Cal. C. B. Irvine. Brief illustrated description of the construction and oiling of more than 30 miles of oiled pavèd streets. 1000 w. Munic Engng—Oct., 1908. No. 95526 C.

Sanitation.

The Transmission of Typhoid Fever. H. E. Jordan. Brief description of nature of the disease and its prevention. Abstract from paper before Indiana Sanitary & Water Supply Assn. 2500 w. Munic Engng—Oct., 1908. No. 95530 C.

Details in Municipal Engineering Work. Harold G. Turner. Gold medal paper read before the Inst. of San. Engrs. Discusses details of buildings, roads and streets, etc. Ills. 5000 w. Surveyor—Oct. 16, 1908. Serial. 1st part. No. 96-048 A.

An Investigation of the Sanitary Condition of the Gowanus Canal, Brooklyn, New York. Charles F. Breitzke. Describes the study made of the unsanitary conditions. Ills. 8000 w. Tech Qr—Sept., 1908. No. 96076 E.

Sewage Disposal.

Report of the Royal Commission on Sewage Disposal. Abstract of Fifth Report. 2600 w. Engr, Lond—Sept. 25, 1908. No. 95671 A.

Incongruities of the Sewage Problem. W. D. Scott-Moncrieff. Comments on the fifth report of the Royal Commission. 4000 w. Surv—Oct. 9, 1908. No. 95978 A.

The Royal Commission on Sewage Disposal. Considers some of the more important conclusions and recommendations of the Commissioners. 4500 w. Builder—Sept. 19, 1908. No. 95430 A.

Sewage Disposal in Columbus, O. Description of new system under installation with plan of sewage disposal plant. 4000 w. Munic Engng—Oct., 1908. No. 95-522 C.

Bacterial Sewage-Disposal. William Ransom. Describes the scientific principles upon which this system is founded. 1200 w. Inst of Civ Engrs—No. 3581. No. 95499 N.

Drying Sewage Sludge in Centrifugal Machines. Describes sludge treatment in favor in Germany. 1200 w. Eng Rec—Oct. 17, 1908. No. 95936.

Drying in Sewage Disposal Practice (Schlammtrocknung für städtische Kanalisationsanlagen). G. ter Meer. Illustrates and describes the apparatus and methods of several German cities, especially the Schäfer-ter Meer centrifugal sewage-drying machine. 4700 w. Zeitschr d Ver Deutscher Ing—Sept. 5, 1908. No. 96190 D.

The Reinforced Concrete Sewer in Avenue A, Borough of the Bronx. Account of large triple sewer of rectangular-barrel system built on marsh land. Plans and diagrams. 3300 w. Eng Rec—Oct. 3, 1908. No. 95613.

The Cost of Constructing a Brick Sewer in Water-Soaked Sand at Gary, Ind. Discussion of the cost of excavating and constructing a sewer 4,258 ft. in length. 1700 w. Engng-Contr—Oct. 7, 1908. No. 95728.

A Large Concrete Sewer Constructed with Adjustable Metal Forms. John M. Bruce. Description of construction of reinforced-concrete outfall sewer in Bronx Borough, N. Y. City. Ills. 3000 w. Eng News—Oct. 8, 1908. No. 95748.

Cost Reducing Concrete Forms. John M. Bruce. Illustrates and describes methods employed in building two concrete sewers in the Borough of the Bronx, New York City. 1500 w. Cement Age—Oct., 1908. No. 96081 C.

Sewer Traps.

Are Intercepting Traps Necessary? E. B. B. Newton. Read before the Roy. Inst. of Pub. Health. Considers reasons for and against their use. 2500 w. Surveyor—Sept. 18, 1908. No. 95435 A.

We supply copies of these articles. See page 579.

WATER SUPPLY.

Conduits.

Progress on the Works of the Southern California Mountain Water Co. Description of a large water supply project for San Diego, Cal. Ills. 3500 w. Eng Rec—Oct. 10, 1908. No. 95740.

Dams.

Development of a Practical Type of Concrete Spillway Dam. Richard Muller. A study based on Bazin's work, "Experiences sur l'Ecoulement en Devorsoir." 1800 w. Eng Rec—Oct. 24, 1908. No. 96034.

Method and Cost of Constructing a Rubble Concrete Dam in the Central States. Describes the earthwork and concrete construction of a water power plant in the Middle West. 2000 w. Engng-Contr—Oct. 7, 1908. No. 95669.

Methods and Costs of Building Earthen Dikes on the Belle Fourche Project and Comments on Spreading Earth. Discusses the construction of a dam for the U. S. Reclamation Service in S. Dak. 3700 w. Engng-Contr—Oct. 7, 1908. No. 95667.

The Yuma Irrigation Dam. Day Allen Willey. Describes the work for the reclamation of arid lands in the southwest, and the problems relating to it. Ills. 1500 w. Sci Am—Oct. 31, 1908. No. 96222.

Construction on the Pathfinder Dam, North Platte Project, U. S. Reclamation Service. E. H. Baldwin. Illustrated description and information concerning the construction of this large masonry dam. 3000 w. Eng News—Oct. 29, 1908. No. 96217.

Filtration.

Infiltration Plant Under Construction at Ironton, Ohio. Philip Burgess. Reviews the history of the water supply, and describes the proposed works, now under construction. 2500 w. Eng Rec—Oct. 17, 1908. No. 95935.

Indiana.

Condition of Indiana Water Supplies. H. A. Barnard. Extract of paper before Indiana Sanitary and Water Supply Assn. Summarizes results of large number of analyses of public and private water supplies. 2000 w. Munic Engng—Oct., 1908. No. 95525 C.

Irrigation.

Irrigation. An informal discussion of the subject by W. W. Follett, Gardner S. Williams, and F. C. Finkle. 6500 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95487 E.

Irrigation in South Africa. A summary of a report by a commission appointed by Lord Milner to investigate inter-colonial irrigation. 2500 w. Engr, Lond—Sept. 18, 1908. No. 95413 A.

Orifices.

Orifices for the Measurement of Water. Franklin Van Winkle. A discussion of the discharge of liquids into air or under water, with reference to the suppression of contraction and the effects of differently framed apertures and ajutages. Ills. 3500 w. Power—Oct. 13, 1908. No. 95837.

Pipe Cleaning.

Methods and Results of Cleaning Water Mains in Pittsburg, Pa. C. O. Daughaday. A paper read before the Central States Water-Works Association. 1400 w. Engng-Contr—Oct. 7, 1908. No. 95729.

Pipe Flow.

Curve Resistance in Water Pipes. George Jacob Davis, Jr. A discussion of the paper by Ernest W. Schoder, describing experiments and considering results. Ills. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95488 E.

See also Valves, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Pipe Lines.

The Construction of Pipe Lines for Gas and Oil. Ulrich Peters. Reviews early work in the United States, the advantages of pipes of different materials, costs, etc. Ills. 1200 w. Min Wld—Sept. 26, 1908. No. 95450.

Pipes.

Cast-Iron Pipe Standard Specifications. Gives two reports issued by the British Engineering Standard Committees, dealing with the standard dimensions, weights, etc., of cast-iron pipes. Ills. 1400 w. Ir & Coal Trds Rev—Oct. 9, 1908. No. 95998 A.

Reservoirs.

The Reinforced-Concrete Covered Reservoir for the Indianapolis Water Co. William Curtis Mabee. Illustrated description of this reservoir and the construction methods. 1500 w. Eng News—Oct. 15, 1908. No. 95956.

Stream Flow.

Flowing-Water Problems. Edgar Charles Thrupp. A study of flow in rivers, particularly the ratio of mean velocity to the maximum surface velocity. 4000 w. Inst of Civ Engrs—No. 3738. No. 95496 N.

Tunnels.

The Blue Island Ave. Tunnel of the Chicago Water-Works System. Illustrated description of the latest tunnel of the distribution system. 2000 w. Eng News—Oct. 22, 1908. No. 96014.

Water Works.

Water Works of Cleveland, Ohio. Information of interest selected from the last annual report. Ills. 3000 w. Munic Jour & Engr—Oct. 14, 1908. No. 95904.

Progress on the Buffalo Water-Works Improvement. Illustrated description including the construction of a new intake crib in Lake Erie, from which a tunnel 6500 ft. long leads to a new pumping station. Ills. 5000 w. Eng Rec—Oct. 10, 1908. No. 95733.

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Well Driller.

The Keystone Gasoline Well Driller. Illustrated description of a driller intended for use where fuel or water is scarce. 1500 w. Ir Age—Oct. 22, 1908. No. 95999.

Well Sinking.

A Concrete Caisson Well. G. E. P. Smith. Illustrated description of a well at Tucson, Arizona. 1000 w. Cement Age—Oct., 1908. No. 96080 C.

WATERWAYS AND HARBORS.

Barge Canal.

The New York State Barge Canal. Illustrated description of work with account of progress made. 1800 w. Sci Am—Oct. 3, 1908. No. 95533.

Breakwaters.

See Caissons, and Piers, under WATERWAYS AND HARBORS.

Caissons.

Reinforced-Concrete Caissons for a Breakwater at Algoma, Wis. W. V. Judson. Describes a novel system of construction in the harbor improvements. Ills. 800 w. Eng News—Oct. 15, 1908. No. 95961.

Cleveland, O.

Development of the Upper Cuyahoga River, Cleveland, Ohio. C. M. Belding. Description of the development of the upper river, including dredging a new channel and dock construction. Ills. 2000 w. Marine Rev—Oct. 18, 1908. No. 95794.

Coast Protection.

Effective Beach Protection. Lewis M. Haupt. Describes various methods in use on the Atlantic Coast. Ill. 2100 w. Cassier's Mag—Oct., 1908. No. 95663 B.

Cofferdams.

A Large Steel-Pile Cofferdam for a Ship Lock at Buffalo, N. Y. Describes an original form of sheet piling used in constructing a ship lock at Black Rock Harbor. Ills. 1500 w. Eng News—Oct. 8, 1908. No. 95750.

Docks.

King's Dock, Swansea. Illustrated description of the important harbor works in course of construction for the port of Swansea. Ills. 2800 w. Engr, Lond—Oct. 2, 1908. No. 95751 A.

Dry Docks.

Floating Dock for Callao. Illustrated account of a new floating dock capable of lifting vessels up to 7,000 tons with a proposed fourth section to be added giving a capacity up to 9,500 tons. 1100 w. Marine Rev—Oct. 1, 1908. No. 95697.

See also Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Europe.

What Europe Is Doing with Waterways. J. A. Ockerson. Abstract of paper read at the Deep Waterway Convention, giving a review of work in this field. 1200 w. Eng News—Oct. 22, 1908. No. 96016.

Floods.

Forests and Floods: Extracts from an Austrian Report on Floods of the Danube, with Applications to American Conditions. H. M. Chittenden. An elaborate discussion, with lengthy editorial. 12500 w. Eng News—Oct. 29, 1908. No. 96219.

Floods in Southern India. Joseph Melville Lacey. Deals with the floods in the Penner river due to the cyclone of November, 1903. Map. 1800 w. Inst of Civ Engrs—No. 3690. No. 95497 N.

Harbors.

See Cleveland, O., Piers, and Tranmere Bay, under WATERWAYS AND HARBORS.

Lighthouses.

Reinforced Concrete Lighthouse. Illustrated description of the new lantern in the Straits of Malacca. 2500 w. Sci Am Sup—Oct. 24, 1908. No. 96017.

Niagara.

Spoliation of the Falls of Niagara. Dr. J. W. Spencer. A study of the physics of the river, the effects of water diversion for power purposes, and the steps necessary for the preservation of the falls. Ills. 5500 w. Pop Sci M—Oct., 1908. No. 95461 C.

Ohio River.

The Improvement of the Ohio River for Navigation. Description of its physical features and of the various engineering works designed to aid navigation. Ills. Also editorial. 5600 w. Eng News—Oct. 8, 1908. No. 95745.

Proposed Reservoir System in Ohio River Basin. H. C. Newcomer. Discussion of a paper by M. O. Leighton advocating reservoirs to control navigation on the Ohio River. The present paper argues against the practicability of the system. Ills. 6000 w. Eng News—Oct. 8, 1908. No. 95744.

Panama Canal.

Impressions Gained from a Visit to the Work on the Panama Canal (Persoonlijke Indrukken van een Bezoek aan de Werken aan het Kanaal van Panama). J. C. Loman. A general review of conditions, methods, progress, etc. 6500 w. De Ingenieur—Sept. 12, 1908. No. 96244 D.

Piers.

The Improvement of the Harbor of Milwaukee, Wis. Illustrates and describes reconstruction of piers and breakwater. 3000 w. Eng Rec—Oct. 24, 1908. No. 96033.

The Extension, Widening and Strengthening of Folkestone Pier. Hugh Torrance Ker. Brief history of the harbor-works and conditions, with description of the new works and their construction. Ills. Discussion. 31000 w. Inst of Civ Engrs, No. 3688—Nov. 12, 1907. No. 95492 N.

Pollution.

The Disposal of the Waste Products of

Gas Works. Discusses the objectionable results from their discharge into streams, and methods of treatment to avoid the trouble. 5000 w. Eng Rec—Oct. 17, 1908. No. 95932.

See also Sanitation, under MUNICIPAL.

River Regulation.

Forests and Reservoirs in Their Relation to Stream Flow, with Particular Reference to Navigable Rivers. H. M. Chittenden. A discussion of this question giving arguments supporting the writer's conclusions. Ills. 25000 w. Pro Am Soc of Civ Engrs—Sept., 1908. No. 95485 E.

See also Ohio River, under WATERWAYS AND HARBORS.

Sea Walls.

The Extension of Governors Island, New York Bay. Describes the sea wall construction, the dredging and filling operations which will add about 101 acres to the island. Ills. 3000 w. Eng Rec—Oct. 24, 1908. No. 96036.

Shore Protection.

The David Neale System of River Improvement and Bank Protection. Charles H. Miller. Information from various papers concerning the woven and fascine types of mattress work, the David Neale system, and other classes of protection used on the Mississippi and Missouri Rivers. 6500 w. Eng News—Oct. 22, 1908. No. 96013.

Tranmere Bay.

The Tranmere Bay Development Works. Somers Howe Ellis. Describes works on the River Mersey, comprising two graving docks, two floating basins, and two sewer culverts. Ills. Discussion. 16000 w. Inst of Civ Engrs, No. 3649—Nov. 26, 1907. No. 95493 N.

Water Powers.

Water Power in the Andes. C. Reginald Enock. Discuss the power potentiality of the streams and rivers of the Andine Slopes. 1300 w. Engr, Lond—Sept. 25, 1908. No. 95666 A.

Developed and Undeveloped Water Powers of Georgia. A review of the various rivers showing the unimproved opportunities. 4500 w. Elec Wld—Oct. 24, 1908. No. 96010.

Economic Problems in the Utilization of German Water Powers (Wasserwirtschaftliche Aufgaben Deutschlands auf dem Gebiete des Ausbaues von Wasserkräften). Theodor Koehn. The first part discusses the practice of other countries. Serial. 1st part. 3200 w. Die Turbine —Sept. 5, 1908. No. 96178 D.

MISCELLANY.

Forestry.

Notes on Canadian Forestry. Stanislas Gagné. A general discussion of this subject. 6000 w. Can Soc of Civ Engrs—Oct., 1908. No. 96072 N.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Determination of Wireless Wave Fronts. Greenleaf W. Pickard. An account of a wireless survey at Amesbury, Mass., to determine the distortion of wireless waves. Ills. 900 w. Elec Rev—Oct. 3, 1908. No. 95882.

The Knudsen Wireless Typewriter. Illustrated description of the invention of Hans Knudsen. 1200 w. Sci Am—Oct. 31, 1908. No. 96221.

The Artom System of Wireless Telegraphy (Sistema Radiotelegraphico Artom). Prof. Alessandro Artom. Illustrated description and theoretical discussion of the system invented by the author. 5000 w. Riv Marit—Sept., 1908. No. 96130 E + F.

See also Oscillations, under ELECTRO-PHYSICS.

Telegraph Printers.

The Creed Telegraph Printer. Describes printing device used in the Creed system to reproduce from a perforated tape received messages in printed characters on a tape. Ills. 1000 w. Elec Rev, Lond—Sept. 25, 1908. No. 95774 A.

Telephone Lines.

See Railway Motors, under DYNAMOS AND MOTORS.

Telephony.

The Telephone Repeater. L. A. Lindsey. A suggestion for constructing a satisfactory repeater. 1000 w. Elec Wld—Oct. 17, 1908. No. 95967.

Telepost.

The Telepost. Report of the Franklin Institute on Science and the Arts on a System of Automatic Telegraphy devised by Patrick B. Delany. Ills. 2400 w. Jour Fr Inst—Oct., 1908. No. 95693 D.

DISTRIBUTION.

Insulators.

Home-Made Insulator Fixtures. George R. Voit. Describes and illustrates a method that will give dependable fixtures. 1500 w. Elec Wld—Oct. 3, 1908. No. 95518.

Wiring.

Wiring and Lighting Equipment of the Stock Room of the New York Public Library. J. F. Musselman, Jr. Illustrated description of the distribution and conditions. 2000 w. Elec Wld—Oct. 17, 1908. No. 95965.

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DYNAMOS AND MOTORS.

A. C. Dynamos.

See Long Distance, under TRANSMISSION.

A. C. Motors.

Improvements in Alternating-Current Motors. Describes four recent patents for improvements in alternating-current motors of the induction, synchronous, series-commutator and series-repulsion types. Ills. 1000 w. Elec Wld—Oct. 10, 1908. No. 95871.

D. C. Motors.

2000-Horse-Power Direct-Current Motor for Driving Converter Blower. Description of a large direct-current motor constructed by the Felten and Guilleaume-Lahmeyerwerke A.-G., Frankfort. 1500 w. Engng—Sept. 25, 1908. No. 95640 A.

Dynamo Sheets.

The Dependence of the Magnetic Properties of Dynamo Sheets on the Direction of Rolling and Their Treatment (Ueber die Abhängigkeit der magnetischen Eigenschaften des Dynamobleches von Walzrichtung und Bearbeitung). E. Gumlich and E. Volthardt. Results of tests at the German Reichsanstalt. Ills. 4400 w. Elektrotech Zeitschr—Sept. 17, 1908. No. 96241 B.

Heating.

The Fundamental Laws of Heating in Electric Machines (Die Grundgesetze der Erwärmung elektrischer Maschinen). Rud. Goldschmidt. An exhaustive mathematical discussion. Ills. Serial. 1st part. 4000 w. Elektrotech Zeitschr—Sept. 10, 1908. No. 96240 B.

Induction Motors.

See Slip Indicators, under MEASUREMENT.

Railway Motors.

Alternating-Current Railway Motors of the Oerlikon Company and Their Effect on Telephone Lines (Ueber Wechselstrombahnmotoren der Maschinenfabrik Oerlikon und ihre Wirkungen auf Telephonleitungen). Hans Behn-Eschenburg. Discusses the inductive effect on telephone lines of the single-phase system and extended investigations by the Oerlikon Company. Ills. Serial. 1st part. 3000 w. Elektrotech Zeitschr—Sept. 24, 1908. No. 96242 B.

Speed Regulation.

The Theory of Regulators (Zur Theorie der Regulatoren). R. v. Mises. A mathematical discussion of regulators as related to the driving at constant speed of electric dynamos. Ills. 4000 w. Elektrotech u Maschinenbau—Sept. 13, 1908. No. 96188 D.

Speed Regulation of Prime Movers (Die Tourenregulierung von Kraftmaschinen mit Hilfe einer Leitgeschwindigkeit mit möglichster Vermeidung der periodischen Schwankungen). Friedrich R. v. Merkl. Refers particularly to the speed regulation of turbine-driven dynamos. Ills. 4000 w. Elektrotech u Maschinenbau—Sept. 6, 1908. No. 96187 D.

Synchronous Motors.

Improving Power Factor by Means of Synchronous Motors. Gives opinions given in the discussion before the Am. St. & Int. Ry. Assn., with comments. 1200 w. Elec Wld—Oct. 17, 1908. No. 95968.

Windage Losses.

Tests on Model Electric Generators for Power Absorbed by Windage. Describes tests made to get an idea of the power lost by windage in the 5000-k.w. generators being installed at Redondo, Cal. Ills. 2500 w. Cal Jour of Tech—Sept., 1908. No. 95519.

ELECTRO-CHEMISTRY.

Electro-Metallurgy.

Electric Furnaces for the Manufacture of Calcium Carbide and Ferrosilicon. Abstract translation of a paper by Dr. Walter Conrad, and discussion. Restricted to an exposition of these industries in Europe. Ills. 6000 w. Elec-Chem & Met Ind—Oct., 1908. No. 95457 C.

Electro-Metallurgy at the Marseilles Exposition (L'Electrométallurgie à l'Exposition de Marseille). M. de Kermond. Brief descriptions of the products and plants of the various exhibitors, especially the Société Electrométallurgique Française. 3000 w. L'Elec'n—Sept. 5, 1908. No. 96115 D.

Electroplating.

The Re-Plating of Old Steel Knives. Detailed description of the work. 3500 w. Brass Wld—Oct., 1908. No. 96083.

The Broderick Automatic Electroplating Machine. Illustrated account of the first attempt to use automatic labor-saving machinery in plating as installed at two large hardware factories. 2000 w. Ir Age—Oct. 8, 1908. No. 95880.

Niagara Falls.

The Industries of Niagara Falls. Raymond H. Arnot. An illustrated review of the industries which have made this region an important electrochemical center. 1800 w. Pop Sci M—Oct., 1908. No. 95462 C.

Nitrogen.

The Utilization of German Water Powers for the Fixation of Atmospheric Nitrogen (Ausnutzung der deutschen Wasserkräfte für die Gewinnung von Luftstickstoff). Herr Dubislav. A plea for the extension of this industry in Germany to supply the demand for nitrate fertilizers. Serial. 1st part. 2200 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 20, 1908. No. 96183 D.

ELECTRO-PHYSICS.

Arcs.

The Electric Arc Between a Solid and a Liquid Electrode. G. Athanasiadis

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Trans. from *Comptes Rendus*. Experimental study to determine the conditions under which an arc may be struck and maintained. 900 w. Elect'n, Lond—Sept. 18, 1908. No. 95440 A.

Oscillations.

High-Frequency Oscillations. William Duddell. From a presidential address before the Roentgen Soc., London. Reviews the methods of producing them. 3500 w. Sci Am Sup—Oct. 31, 1908. No. 96223.

Rodio-Activity.

Present Knowledge of Radio-Activity (L'Etat actuel de nos Connaissances sur la Radio-Activité). A. Debierne. The two parts discuss the discovery and transformations of radio-active bodies. Ills. Serial. 2 parts. 1600 w. Rev Gen des Sci—Sept. 15 and 30, 1908. No. 96113 each D.

GENERATING STATIONS.

Accumulators.

The Regulating Plant at Sandviken, Sweden (L'Impianto di Compensazione di Sandviken, Svezia). Illustrates and describes the storage battery and booster installations and gives results obtained in service. 3600 w. Elettricita—Aug. 27, 1908. No. 96134 D.

See also Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Central Stations.

Columbus Municipal Lighting Plant. Describes growth and operation of 3300 h.p. power plant. 4000 w. Munic Jour and Eng—Oct., 1908. No. 95701.

Recent Power Plant Development of the Brockton Edison Company. Illustrated description of the new steam-turbine generating plant. 2000 w. Elec Wld—Oct. 3, 1908. No. 95510.

The Power Development of the Northern Colorado Power Company. Illustrated detailed description of a plant producing electric power directly at the coal mine and transmitting to towns and cities. 2000 w. Elec Age—Sept., 1908. No. 95504.

Report of the Committee on Power Generation, Am. St. & Int. Ry. Assn. (Abstract.) The subjects considered are the practical operation of steam turbines, steam motors, and flue gas analyzers. 6500 w. Elec Ry Jour—Oct. 15, 1908. No. 95922.

The Reconstruction of an Electric Lighting Scheme. C. M. Shaw. Read before the Incor. Munic. Elec. Assn. Describes methods adopted at Worcester, Eng. 1700 w. Mech Engr—Sept. 18, 1908. Serial. 1st part. No. 95428 A.

Rules Governing the Installation of Electrical Machinery and Apparatus (Instructions sur le Montage des Installations électriques). The text of regulations adopted by several of the important manufacturers' associations in France. Serial. 1st part. 6000 w. L'Elec'n—Sept. 5, 1908. No. 96117 D.

Depreciation.

The Obolescence of Electric Lighting Plant. F. Fernie. Describes an insurance fund against obolescence. Diagrams. 2400 w. Elec Rev, Lond—Sept. 25, 1908. No. 95775 A.

Design.

The Lay-Out of Central Station Plant with a View to Reliability. J. Salisbury and W. S. Burge. Suggestions for central station design. 1500 w. Elec Rev, Lond—Oct. 9, 1908. No. 95984 A.

Economies.

The Contractor and the Central Station. Samuel J. Robinson. The importance of the electrical contractor and his relation to the central station. 1200 w. Elec Wld—Oct. 3, 1908. No. 95517.

Hydro-Electric.

The Most Important Hydro-Electric Installation in Europe. Enrico Bignami. Illustrated detailed description of the Brusio station and its equipment. 3500 w. Engineering Magazine—Nov., 1908. No. 96202 B.

Hydro-Electric Power Plant of the Inland Empire System. Illustrated description of new generating station for the Spokane & Inland Empire R. R. Co. on the Spokane River. 4400 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95674 C.

The Nine-Mile Hydro-Electric Development on the Spokane River. Illustrated description of a large power plant on the Spokane River for the Spokane and Inland Railroad Co. Ills. 4200 w. Eng Rec—Oct. 10, 1908. No. 95735.

Discussion on "Water Power Development in the National Forests. A Suggested Government Policy." Reports a discussion at Atlantic City, N. J., June 29, 1908. 7000 w. Pro Am Inst of Elec Engrs—Oct., 1908. No. 95521 D.

Isolated Plants.

Large Oil-Engine Electrical Plant. Illustrated description of plants erected to supply energy for lamps and motors at two phosphate mines. 1500 w. Elec Wld—Oct. 3, 1908. No. 95512.

Electricity in Factories. Alexander Colin Anderson. Considers the design and general lay-out of an electrical installation, without dealing with the cost. 6000 w. Inst of Civ Engrs—No. 597. (Students' paper.) No. 95500 N.

Power for a Large Manufacturing Works. Osborn Monnett. Illustrated description of the Western Electric Co.'s plant at Chicago. 3000 w. Power—Oct. 27, 1908. No. 96067.

Lighting Country Homes by Private Electric Plants. T. H. Amrine. Traces the design of a private electric plant of sufficient size to light a country home with 25-volt tungsten lamps. Also gives

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a lighting scheme for a medium sized private residence. 11000 w. Univ of Ills, Bul. No. 25—July 13, 1908. No. 95460 N.

Japan.

Modern Steam and Hydraulic Generating Stations in Japan. M. Kawara. Describes two typical modern plants. Ills. 1500 w. Elec Wld—Oct. 24, 1908. No. 96011.

Labor.

Labor Requirements in Representative Massachusetts Central Station Organizations. Summary of statistics submitted to the Mass. Board of Gas and Electric Light Commissioners for ten representative companies. 2100 w. Elec Wld—Oct. 10, 1908. No. 95875.

Rates.

Charges for Electrical Energy. James L. Roberts. A discussion of "rates" and "ratings." 1600 w. Elec Wld—Oct. 3, 1908. No. 95516.

Rates and the Use of Rates. H. H. MacPherson. Discusses flat rates and sliding-scale rates, readiness-to-serve rates, etc. 1600 w. Elec Wld—Oct. 3, 1908. No. 95515.

Switchboards.

High-Tension Switchboard Practice in America. Stephen Q. Hayes. Illustrated detailed description of plants employing three-phase circuits, and obtaining the high voltage by means of transformers. 5500 w. Elec Age—Sept., 1908. No. 95502.

LIGHTING.

Arc Lamps.

See Street, under LIGHTING.

Illumination.

See Mercury Vapor, under LIGHTING; and Wiring, under DISTRIBUTION.

Incandescent Lamps.

Public Lighting by Incandescent Lamps. Brief discussion of best system to meet conditions. 1400 w. Elec Rev, Lond—Oct. 9, 1908. No. 95983 A.

Metallic Filament Lamps (A propos des Lampes à Filament Métallique). M. Henry. Discusses their possible effect on the development of private lighting plants. 2000 w. L'Elec'n—Sept. 5, 1908. No. 96116 D.

The Influence of Excess Voltages on the Life of Metallic Filament Lamps (Einfluss von Spannungsüberschreitungen auf die Lebensdauer von Metallfaden-Glühlampen). H. Remané. A record of the results of elaborate tests. Ills. 2800 w. Elektrotech Zeitschr—Sept. 3, 1908. No. 96197 B.

Mercury Vapor.

Illumination Calculations for Mercury Vapor Lamps (Beleuchtungsberechnungen für Quecksilberdampflampen). N. Norden. Develops formulæ for the distribution of light from linear incandescent bodies. Ills. 2000 w. Elektrotech Zeitschr—Sept. 10, 1908. No. 96199 B.

Photometry.

The Photometric Standard of the Natural Physical Laboratory. R. T. Glazebrook. A report presented to Section A of the British Association, giving a description of the use of the 10 c.p. Vernon Harcourt pentane lamp certified by the Gas Referees and its relation to the Hefner standard. 2000 w. Elect'n, Lond—Sept. 25, 1908. No. 95780 A.

Street.

American and European Street Lighting. Dr. Louis Bell. A comparison, unfavorable to America. 1200 w. Elec Wld—Oct. 3, 1908. No. 95509.

Electric Lighting. W. L. Puffer. Discusses statistics of comparative costs in Massachusetts cities as compiled from the Report of the Mass. Gas & Electric Light Commission for 1907. 1000 w. Munic Jour & Eng—Oct. 7, 1908. No. 95702.

The Arc Lighting System of Portland, Oregon. B. C. Coldwell. Brief description of new installation of magnetite lamps supplied from constant current transformers and mercury vapor rectifiers. Abstract from Gen. Elec. Review. 900 w. Munic Engng—Oct., 1908. No. 95531 C.

Tunnels.

See Subway Lighting, under STREET AND ELECTRIC RAILWAYS.

MEASUREMENT.

Instruments.

Measurements with Portable Instruments. F. P. Cox. Discusses the care of instruments and the measurement of potential, current, energy, and time. 2800 w. Elec Rev, N Y—Oct. 17, 1908. No. 95911.

Meters.

A Two-Armature Meter (Compteur à deux Induits sans Démarrage). M. Willot. Illustrated description and discussion of the theory of the Paulet meter. 5000 w. Soc Belge d'Elec'n—Sept., 1908. No. 96101 E.

Meter Testing.

The Calibration of Portable Watt-Hour Meters. Charles F. Hunter. Describes methods of testing, especially one which checks the standard as used. 500 w. Elec Wld—Oct. 31, 1908. No. 96215.

Power Factor.

The Measurement of Power Factor. Charles V. Drysdale. Notes on methods of Dr. Lulofs for accurate alternate-current testing. 1100 w. Elect'n, Lond—Sept. 18, 1908. No. 95441 A.

Slip Indicator.

Measuring the Slip and Speed of Induction Motors. Charles A. Perkins. Describes the design and operation of a slip indicator. 800 w. Elec Wld—Oct. 31, 1908. No. 96213.

Units.

The International Conference on Electrical Units and Standards. An account of the conference in London to establish

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a universal system of standards. 4000 w. Engng—Oct. 16, 1908. Serial. 1st part. No. 96056 A.

TRANSMISSION.

Cables.

Advantages in the Use of High-Tension Underground Cables. Henry Floy. Considers some of the advantages and their reliability. 1000 w. Elec Wld—Oct. 31, 1908. No. 96216.

Insulating and Sheathing High-Tension Underground Cables. Henry Floy. Describes methods used for such conductors. 2500 w. Elec Wld—Oct. 3, 1908. No. 95513.

Grounding.

Grounding a Transmission System Through a Special Transformer. Description of grounding transformer and diagram showing its connection with the high tension of the distributing system, as used on the Twin City Rapid Transit system. 700 w. Elec Ry Jour—Oct. 3, 1908. No. 95589.

Insulation.

The Fatigue of Insulation. A. S. Langsdorf. An account of research work, with editorial. 2500 w. Elec Wld—Oct. 31, 1908. No. 96212.

Line Design.

Long Distance Transmission (Les Grandes Transmissions d'Energie Electrique). E. Barthélemy. A general review of the principles of transmission line design, choice of current and voltage, line location and construction, etc. 7200 w. Rev Gen des Sci—Sept. 30, 1908. No. 96114 D.

Overhead Lines. H. B. Gear and P. F. Williams. Detailed description of the best American practice. Ills. 4000 w. Elec Age—Sept., 1908. No. 95503.

Lines.

Steel Tower Transmission Line. Illustrates and describes interesting features of a line under construction at Milwaukee, Wis. 1000 w. Elec Wld—Oct. 3, 1908. No. 95511.

Long Distance.

Long-Distance Electrical Transmission. C. J. Spencer. Considers the need of a new type of generator and suggest methods for overcoming present limitations of distance. Illus. 3000 w. Cassier's Mag—Oct., 1908. No. 95664 B.

Poles.

Reinforced-Concrete Poles. Recent European experiments by Siegwort for making reinforced-concrete poles for telegraph, telephone and power lines. Illustrated description of machinery and poles, and pipes made by the process. 1300 w. Sci Am Sup—Oct. 3, 1908. No. 95534.

Rotary Converters.

Voltage Variation in Rotary Converters. F. D. Newbury. Traces the development of methods of direct-current variation involving a change in the a. c. voltage, and compares the booster method with the split-pole method. Ills. 5000 w. Elec Jour—Nov., 1908. No. 96455.

Transformers.

Care and Operation of Transformers. Fred. Dubell. Discusses points relating to safety, efficiency, etc. 1800 w. Elec Wld—Oct. 3, 1908. No. 95514.

Magnetic Reluctance of Joints in Transformer Iron. H. Bohle. Abstract of a paper before the Institution of Electrical Engineers. 1200 w. Elect'n, Lond—Oct. 2, 1908. No. 95785 A.

The Effect of Wave Form Upon the Voltage Ratio of Transformers. Morton G. Lloyd. Gives results of experimental tests showing there is a small change in the ratio, though negligible for practical purposes. 1000 w. Elec Wld—Oct. 17, 1908. No. 95966.

The Combination of Voltage and Current Transformers (Die Vereinigung von Spannungs- und Stromtransformatoren). Robert Moser. A mathematical discussion. Ills. Serial. 1st part. 5000 w. Elektrotech u Maschinenbau—Sept. 27, 1908. No. 96189 D.

See also Grounding, under TRANSMISSION.

Underground.

High-Potential Underground Transmission. P. Junkersfeld and E. O. Schweitzer. A discussion of this system with a view of pointing out some lessons taught by experience and tests and of suggesting further investigation. 6000 w. Pro Am Inst of Elec Engrs—Oct., 1908. No. 95520 D.

See also Cables, under TRANSMISSION.

MISCELLANY.

Agriculture.

The More Extended Application of Electricity in Agriculture (Die erweiterte Anwendung des elektrischen Betriebes in der Landwirtschaft). Kurt Krohne. The first part reviews the present use of electricity on farms in Germany, discusses its possibilities for usefulness, and begins a description of motor-driven plows. Ills. Serial. 1st part. 3500 w. Elektrotech Zeitschr—Sept. 24, 1908. No. 96243 B.

Contracts.

Contracts for Electrical Work and Machinery. Discusses contracts for the erection of plant and machinery from a legal point of view. 4000 w. Engr, Lond—Oct. 30, 1908. No. 96444 A.

Marseilles Congress.

The Electrical Congress at Marseilles. Outline account of Congress held Sept. 13-20, 1908. 2700 w. Elec Rev, Lond—Oct. 2, 1908. No. 95777 A.

International Congress of the Applications of Electricity (Congrés international des Applications de l'Electricité). J. A. Montpellier. A report of the proceedings. Serial. 1st part. 10000 w. L'Elec'n—Sept. 26, 1908. No. 96118 D.

We supply copies of these articles. See page 579.

INDUSTRIAL ECONOMY

Accounting.

Commercial Engineering. First of a series of articles dealing with the efficient management of the commercial side of an engineering business. 1500 w. Mech Wld—Oct. 2, 1908. Serial. 1st part. No. 95900 A.

Apprenticeship.

Second Annual Conference of the Apprentice Instructors, N. Y. Central Lines. Abstract of proceedings of conference held at Depew, N. Y., Sept. 3, 1908. Gives papers and reports describing methods and results. 16000 w. Am Eng & R R Jour—Oct., 1908. No. 95538 C.

The Crisis of Apprenticeship (La Crise de l'Apprentissage). A discussion of conditions in France. Serial. 1st part. 2000 w. Monit Indus—Sept. 19, 1908. No. 96121 B.

Cost Estimation.

Estimating and Rate-Fixing for Fitting and Machine Shops. A. E. Ragot. Discusses method of estimating costs of production. Serial. 1st part. 2100 w. Engr, Lond—Sept. 25, 1908. No. 95672 A.

Cost Systems.

Systematic Foundry Operation and Foundry Costing. C. E. Knoeppel. This second article of a series considers the importance of correct burden apportionment. 5000 w. Engineering Magazine—Nov., 1908. No. 96204 B.

Education.

The New Engineering Laboratories and Workshops at the Heriot-Watt College, Edinburgh. Describes mechanical equipment. 1200 w. Elect'n, Lond—Oct. 2, 1908. No. 95783 A.

The Relation of American Mining Schools to the Mineral Industry. L. E. Young. Discusses present status of the industry and the importance of technical training. Ills. 4500 w. Pro St Louis Ry Club—Sept. 11, 1908. No. 95692.

High School Instruction in Naval Engineering in Germany (Der Hochschulunterricht auf schiffbautechnischen Gebieten in Deutschland). O. Flamm. A discussion of courses of instruction, facilities, and conditions. 10000 w. Deutscher Schiffbau—1908. No. 96159 N.

Germany.

Machine Tool Industry in Continental Europe. G. L. Carden. Review of the special investigations conducted by the U. S. Dept. of Labor during the past six months. 2500 w. Am Mach—Vol. 31. No. 44. No. 96211.

Industrial Betterment.

"Welfare Work" on American Railroads. William Menkel. Illustrated account of efforts to improve conditions of railroad employees. 7000 w. Am Rev of Rev—Oct., 1908. No. 95598.

See also Employees, under STREET AND ELECTRIC RAILWAYS.

Labor.

Industrial Peace and Industrial Efficiency. Abstract of a speech by Sir Christopher Furness, before a conference of trades union representatives submitting proposals for the prevention of labor troubles. 4000 w. Engr, Lond—Oct. 9, 1908. No. 95995 A.

Management.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This fifth article of a series describes a successful attempt to apply staff and standards to a particular shop. 3500 w. Engineering Magazine—Nov., 1908. No. 96201 B.

A Cost System for a Large Manufacturing Plant. Oscar E. Perrigo. This tenth and final article in a series on Shop Management and Cost Keeping, describes requirements of a good cost system and the classifications of accounts. Ills. 6000 w. Ir Trd Rev—Oct. 1, 1908. No. 95585.

Organization of the Personnel of an Engineering Works. Matthew Lang. First part of a paper read before the Institute of Engineers in which is discussed the factors making for efficient organization. 1800 w. Mech Wld—Oct. 2, 1908. No. 95869 A.

Securing the Co-operation of the Workman in the Improvement of Workshop Methods, etc. R. W. Kenyon. Abstract of paper read before the British Found. Assn. Outlines the scheme in operation at Accrington. 3000 w. Ir & Coal Trds Rev—Sept. 18, 1908. No. 95438 A.

See also Pattern Shops, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Patents.

The Recent Change in British Patent Law. Discussion by an "English Barrister" of the recent alteration of the law and its benefits and disadvantages to the foreign inventor. 2200 w. Elec Wld—Oct. 10, 1908. No. 95873.

Trusts.

A German Manufacturers' Protective Organization. A short account of the German Kartell from the German point of view. 2500 w. Elect'n, Lond—Oct. 9. 1908. No. 95985 A.

Wages.

Different Plans of Paying Employees. Harrington Emerson. Discusses their advantages and disadvantages. 2500 w. Ir Age—Oct. 22, 1908. No. 96004.

We supply copies of these articles. See page 579.

MARINE AND NAVAL ENGINEERING

Armor.

Armor-Piercing Projectiles (Ueber die Wirkungsweise der Panzergeschosse). J. Castner. A discussion of modern armor and projectiles inspired by Capt. Tressider's paper before the Inst. Nav. Archs. Ills. 2800 w. Stahl u Eisen—Sept. 2, 1908. No. 96137 D.

Barges.

A Barge for Transporting and Unloading Coke, New York Harbor. Illustrated description of a 420-ton barge fitted with conveying machinery for the discharge of its cargo. Ills. 2100 w. Eng Rec—Oct. 10, 1908. No. 95738.

Battleships.

H. M. Battleships "Agamemnon" and "Lord Nelson." Brief description with plates of boilers and engines. 300 w. Engng—Sept. 25, 1908. No. 95645 A.

Cable Steamers.

The Cable Steamer Guardian. Illustrated description of a twin screw cable-repairing steamer of the Central and South American Telegraph Co. of N. Y. for work in the South Pacific. 500 w. Int Marine Engng—Oct., 1908. No. 95553 C.

Cruisers.

Russian Armored Cruiser "Admiral Makaroff." J. G. Peltier. Illustrated description of 7877-ton cruiser built in France. 1000 w. Int Marine Engng—Oct., 1908 No. 95552 C.

Davits.

The Handling of Battleship Boats. Proposed installation of Welin quadrant davits on U. S. Battleships. Ill. 1200 w. Int Marine Engng—Oct., 1908. No. 95551 C.

Development.

Presidential Address of Sir William Matthews. Refers particularly to branches of engineering work associated with oversea traffic. 17500 w. Inst of Civ Engrs—Nov. 5, 1907. No. 95491 N.

Dredges.

A Novel Pneumatic Dredge. Illustrated description of a dredge in use at Sacramento, Cal. 1100 w. Compressed Air—Oct., 1908. No. 96086.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Power.

Electric Propulsion of Ships with Note on Screw Propellers. Henry A. Mavor. Paper and discussion with plans and diagrams. 2500 w. Trans Inst Eng & Ship in Scot—Vol. 51, Feb. 18, 1908. No. 95607 N.

The German Shipbuilding Exposition, Berlin, 1908 (Deutsche Schiffbau-Ausstellung Berlin, 1908). F. Thilo. Illustrated description of the exhibits of electrical machines and apparatus. Serial. 1st part. 2400 w. Elektrotech Zeitschr—Sept. 10, 1908. No. 96198 B.

Electricity on Shipboard (Elektrische Schiffsanlagen). C. Arldt. Discusses the various appliances and illustrates and describes various types of apparatus for light, power, and communication plants. Ills. 7500 w. Deutscher Schiffbau—1908. No. 96164 N.

See also Ferry Boats, under MARINE AND NAVAL ENGINEERING.

Exhibitions.

The Berlin Marine Exhibition. Max A. R. Bruenner. Illustrated description of the exhibition of 1908 with comments on the growth of German maritime industries. 3500 w. Cassier's Mag—Oct., 1908. No. 95659 B.

Ferry Boats.

An Electric Ferry-Boat on the Rhine. Dr. M. Erb. Illustrated detailed description of the largest electrically-propelled boat on German waters. 1200 w. Elec Engng—Oct. 8, 1908. No. 95981 A.

Fire Boats.

Fire Fighting Equipment for Tugboats. R. H. Newbern. Description of fire pumps for railroad and other tugboats as used on the Atlantic Seaboard. Ills. 2400 w. Marine Rev—Oct. 1, 1908. No. 95699.

Gas Engines.

Gas-Engines in H. M. S. "Rattler." Brief description of 500 h.p. suction producer and marine gas engine for a gunboat 165 ft. long. 1800 w. Engng—Oct. 2, 1908. No. 95716 A.

Marine Gas Engines (Ueber Schiffsgasmaschinen). F. Romberg. A general review of the application of combustion motors to marine propulsion, their advantages and economy, and the leading types. Ills. 14000 w. Deutscher Schiffbau—1908. No. 96158 N.

Gasoline Engines.

New Austrian Patrol Boat Engines. Illustrated description of 300 h.p. gasoline engines for two iron Danube patrol boats with results of tests. 800 w. Int Marine Engng—Oct., 1908. No. 95547 C.

German Navy.

The Development of the German Navy (Die Entwicklung des schwimmenden Materials der deutschen Marine). J. Rudloff. An illustrated historical review of progress in warship construction since 1843. 10000 w. Deutscher Schiffbau—1908. No. 96154 N.

Germany.

See Education, and Shipbuilding, under MARINE AND NAVAL ENGINEERING.

We supply copies of these articles. See page 579.

Mauretania.

The Electrical Equipment of the Cunard Express Steamer "Mauretania." W. C. Martin. Paper and discussion with plans and diagrams. 9000 w. Trans Inst Eng & Ship in Scot—Vol. 51, March 31, 1908. No. 95606 N.

Motor Boats.

Development of the Motor Life-Boat. Brief illustrated description of a vessel of the self-righting type. 700 w. Sci Am Sup—Oct. 24, 1908. No. 96018.

Sea-Going Motor Boats (Seegehende Motorboote). Carl Pillepich. The first part discusses the basis of measurement of boats for competitions, giving the formulæ used by several clubs. Ills. Serial. 1st part. 2300 w. Zeitschr d Mit Motorwagen Ver—Sept. 30, 1908. No. 96169 D.

Naval Organization.

The Effectiveness of the Bureau System in Naval Organization. Shows that the efficiency of the systems has been proved. 4000 w. Engineering Magazine—Nov., 1908. No. 96200 B.

Oil Engines.

100-Brake-Horse-Power Paraffin-Motor. Illustrated description of the Parsons motor for marine purposes. 500 w. Engng—Sept. 18, 1908. No. 95417 A.

Propellers.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

Salvage Steamer.

New Life-Saving Steamer Snohomish. Description of a 795 ton vessel designed for saving life and maritime property in the Pacific Northwest. Ills. 1000 w. Naut Gaz—Oct. 8, 1908. No. 95870.

Salving.

The Salving of H. M. Cruiser "Gladiator." An illustrated detailed account of the methods used to salve this battleship sunk by the "St. Paul." Plates. 5200 w. Engng—Oct. 9, 1908. No. 95993 A.

Shipbuilding.

New shipbuilding works of Smith's Dock Company, Ltd. The present part describes the general character of two graving docks on the Yorkshire side of the Tees. Ills. 1800 w. Engng—Oct. 2, 1908. Serial. 1st part. No. 95709 A.

The New Yarrow Yard at Scotstown, Glasgow. Illustrated description of a new 12-acre yard on the Clyde for the construction of torpedo boats and torpedo-boat destroyers and shallow draft steamers. 1100 w. Int Marine Engng—Oct., 1908. No. 95550 C.

A German Shipbuilding Yard. Description of the Stettin yard of the Stettiner Maschinenbau Aktien Gesellschaft Vulcan. Illus. 3000 w. Engr, Lond—Sept. 25, 1908. No. 95668 A.

German Dockyards (Werftanlagen). W. Laas. A review of German dockyards and shipbuilding works, their extent, organization, capacity, equipment, etc. Ills. 7500 w. Deutscher Schiffbau—1908. No. 96161 N.

The German Shipbuilding Industry (Die deutsche Schiffbau-Industrie). F. Meyer. A review of its development and present condition, statistics of the various firms and their present activities, etc. Ills. 10000 w. Deutscher Schiffbau—1908. No. 96163 N.

The German Iron and Steel Industry and German Shipbuilding (Die deutsche Eisen- und Stahlindustrie und der deutsche Schiffbau). Fritz Lürmann. Discusses the relations between the steel and shipbuilding industries, the production of shipbuilding materials, etc. Ills. 5500 w. Deutscher Schiffbau—1908. No. 96160 N.

Ship Design.

The Weights of Vessels. A. R. Liddell. Discussion of possible reductions in the weight of large steamships and the effect on the general design. 3200 w. Int Marine Eng—Oct., 1908. No. 95546 C.

Ship Equipment.

Ships' Equipment (Ausstattung und Ausrüstung). Fr. Jappe. Discusses and describes types of equipment for heating ventilating, anchor chains, davits, refrigerating machines, etc. Ills. 9000 w. Deutscher Schiffbau—1908. No. 96165 N.

Ship Heating.

The Heating and Ventilating of Ships. S. F. Walker. Illustrated description of ventilating fans and discussion of power and heat required. Serial. 1st part. 4200 w. Int Marine Engng—Oct., 1908. No. 95545 C.

Ship Ventilation.

Ventilation and Sanitation. A. E. Battle. Read at Olympia before the Inst. of Marine Engrs. Discusses ventilation, heating, and berthing arrangements on board ship. 4000 w. Marine Rev—Oct. 15, 1908. No. 95905.

See also Ship Heating, under MARINE AND NAVAL ENGINEERING.

Steam Boilers.

The Use of Sea Water in Marine Boilers. James Shirra. A paper read before the Institute of Marine Engineers which discusses its use and its dangers. 1200 w. Marine Rev—Oct. 18, 1908. No. 95795.

The Use of Lime in the Modern Marine High Pressure Boiler. Discusses the use of lime to counteract the effects of harmful lime salts, acids from oils and various free gases. Illus. 4500 w. Marine Rev—Oct. 1, 1908. No. 95700.

Marine-Boiler and Auxiliary-Machinery Construction in Germany (Entwickelung und Stand des Schiffskessel- und Schiffshilfsmaschinenbaues in Deutschland). Walter Mentz. An illustrated review of progress and present practice. 5000 w. Deutscher Schiffbau—1908. No. 96157 N.

Steam Engines.

The Machinery of H. M. Battleships "Agamemnon" and "Lord Nelson." Drawings and description of the main engines. Plate. 700 w. Engng—Sept. 18, 1908. No. 95420.

The Modern Construction and Future Prospects of the Marine Reciprocity Engine (Die Schiffskolbenmaschine, ihre moderne Konstruktion, ihre Aussichten für die Zukunft). P. Krainer. A general review, discussing the competition of the steam turbine and of the internal-combustion engine. Ills. 7500 w. Deutscher Schiffbau—1908. No. 96155 N.

Steamships.

A New Patrol Steamer for Fishery Duties. Illustrated description of the SS. James Fletcher, a 420-ton vessel built for Lancashire and Western Sea Fisheries Committee. 2200 w. Int Marine Engng—Oct., 1908. No. 95549 C.

The New Italian Steamship Europa. D. Attilio. An illustrated description of a 11,575-ton passenger steamship for the Veloce Company of Genoa. 1500 w. Int Marine Engng—Oct., 1908. No. 95544 C.

The Atlantic Liner Chicago. J. G. Peltier. Illustrated description of 14,500-ton steamship of the trans-Atlantic fleet of the Compagnie Generale Transatlantique. 1200 w. Int Marine Engng—Oct., 1908. No. 95548 C.

Launch of the White Star Dominion Liner Laurentic. Illustrated account of a new steamship for the Canadian trade 565 ft. long and 14,500 tons gross. 1500 w. Marine Rev—Oct. 1, 1908. No. 95698.

The Turbine Steamships "Heliopolis" and "Cairo" of the Egyptian Postal Company (Les Paquebots à Turbines "Heliopolis" et "Cairo" de la Compagnie Postale Egyptienne). L. Piaud. Illustrated description. Ills. 2000 w. Génie Civil—Sept. 12, 1908. No. 96123 D.

Steam Turbines.

Impulse or Reaction Turbines (Druck- oder Ueberdruckturbine)? Felix Langen. A discussion of the comparative efficiency and economy of the two types. 3200 w. Schiffbau—Sept. 9, 1908. No. 96153 D.

The Steam Turbine for Ship Propulsion (Die Dampfturbine im Schiffsbetriebe). H. Schmidt. Reviews the types now used for marine propulsion, the advantages and disadvantages of steam turbines, etc. Ills. 12000 w. Deutscher Schiffbau—1908. No. 96156 N.

Water Supply.

A New Method of Sterilizing Drinking Water on War Ships (Di un nuovo Sistema di Sterilizzazione dell' Acqua potabile a Bordo delle Navi da Guerra). A. Delogu. Discusses sterilization with ozone. 4000 w. Riv Marit—Sept., 1908. No. 96131 E + F.

MECHANICAL ENGINEERING

AUTOMOBILES.

Armstrong-Whitworth.

18-22 H.P. Armstrong-Whitworth Chassis. Illustrated description. 900 w. Autocar—Oct. 10, 1908. No. 95974 A.

Brasier.

The 1908 Brasier Petrol Cars. Illustrated detailed description. 1500 w. Auto Jour—Oct. 10, 1908. Serial. 1st part. No. 95976 A.

Cabs.

Motor Cabs in Long Island Efficiency Test. Illustrated description of a test of cabs held by N. Y. Automobile Trade Association in a run from Brooklyn to Montauk and back. 650 w. Com Veh—Oct., 1908. No. 95578.

Motor Cabs (Automobildroschken). Max R. Zechlin. Discusses their operating expenses, revenues, and profits in Berlin. 3200 w. Zeitschr d Mit Motorwagen Ver—Sept. 15, 1908. No. 96167 D.

Clutches.

The Utility of Automobile Clutches. Thomas J. Fay. Considers types, design, materials, etc. Ills. 4000 w. Automobile—Oct. 15, 1908. Serial. 1st part. No. 95913.

Commercial Vehicles.

Recent Developments in Motor Vehicles for Industrial Purposes. Harry Wilkin Perry. This first of two articles deals mainly with mechanical improvements and operating expenses. Ills. 3500 w. Engineering Magazine—Nov., 1908. No. 96205 B.

Improved Steam Wagon. Illustrated description of an English built vehicle. 1000 w. Engr, Lond—Oct. 9, 1908. No. 95996 A.

Electric Vehicle Construction and Operation. Loftus G. Coade. Introductory chapter of a series of articles on causes of trouble in electric vehicle installations. 2500 w. Com Veh—Oct., 1908. No. 95580.

Development of the Motor Cycle Van. Describes various forms of motor vehicles for the delivery of light packages. Ills. 1100 w. Com Veh—Oct., 1908. No. 95575.

Commercial Vehicles in French Army Maneuvers. Illustrated description of use of 70 motor vehicles by two army corps for the daily transport of bread. 550 w. Automobile—Oct. 1, 1908. No. 95560.

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Delivery Operation in Pittsburg. Illustrated description of the operation of 1-ton Frayer-Miller 4-cylinder delivery wagons for a department store. 800 w. Com Veh—Oct., 1908. No. 95577.

See also History, under STREET AND ELECTRIC RAILWAYS.

Competitions.

The Four-Inch Race. Gives descriptions of some of the competing cars. Ills. and map. 5500 w. Autocar—Sept. 19, 1908. No. 95432 A.

Design.

What Constitutes a Handsome Car? Interesting discussion of the designs of automobile bodies. Ills. 1500 w. Autocar—Oct. 3, 1908. No. 95887 A.

See also Ball Bearings, under MACHINE ELEMENTS AND DESIGN.

Drive Axle.

The Dieterich Universal Drive Axle. Illustrated description of the mechanism and its action. 2200 w. Ir Age—Oct. 22, 1908. No. 96002.

Elmore.

The 1909 Models of the Two-Cycle Elmore. Illustrated description. 600 w. Automobile—Oct. 1, 1908. No. 95557.

Farm Motors.

Agricultural Tractor Trials at Winnipeg. Illustrated description of competitive tests of agricultural tractors with wagons and plows. 1300 w. Com Veh—Oct., 1908. No. 95579.

See also Agriculture, under ELECTRICAL ENGINEERING, MISCELLANY.

Fuels.

Mixed Fuels for Automobile Engines. T. L. White. Discusses additions of various substances to alcohol with particular reference to the admixture of acetylene. 3000 w. Automobile—Oct. 1, 1908. No. 95555.

Benzol or Benzine (Benzol contra Benzin). Otto Lüders. The comparative economy of these two fuels for automobiles is discussed. 1800 w. Zeitschr d Mit Motorwagen Ver—Sept. 30, 1908. No. 96168 D.

Fuel Testing.

A Simple Method of Testing Petrols. J. E. Stacey Jones. Describes simple tests with apparatus at hand. Ills. 1500 w. Autocar—Oct. 10, 1908. No. 95975 A.

Gears.

The Donkin Differential. Illustrated description of a differential mechanism without gear wheels. 2000 w. Auto Jour—Sept. 26, 1908. No. 95650 A.

Haynes.

Haynes 1909 Model. Illustrated description of Model X, a car of medium power, size and price. 1600 w. Automobile—Oct. 1, 1908. No. 95556.

Ignition.

High Tension Magneto-Ignition Systems. Describes and illustrates the Nieuport, a French high tension magneto. 1500 w. Auto Jour—Sept. 26, 1908. No. 95648 A.

Motor Rating.

The Rating of Motor-Car Engines. Discusses a report of a sub-committee of the Society of Motor Manufacturers and Traders, objecting to the rules of the Royal Automobile Club. 1000 w. Engng—Sept. 25, 1908. No. 95643 A.

Motors.

Concerning the Silent Knight Motor. Thomas J. Fay. An illustrated discussion of this motor and its claims. 2000 w. Automobile—Oct. 22, 1908. No. 96020.

The New Daimler Slide Valve Motor-Car Engine. Views and description of the construction. 1200 w. Mech Engr—Oct. 16, 1908. No. 96049 A.

The 1909 Daimler Engine. Illustrated description of a new design of 4-stroke motor having cylindrical sliding valves. 1800 w. Autocar—Sept. 19, 1908. No. 95431 A.

Motor Timing.

What Is the Best Motor Timing? Louis Lacoin. An examination of timing arrangements and regulations. 2500 w. Automobile—Oct. 29, 1908. Serial. 1st part. No. 96234.

Napier.

The 45 H.P. 1909 Six-Cylinder Napier Car. Illustrates and describes special features. 1200 w. Autocar—Sept. 19, 1908. Serial. 1st part. No. 95433 A.

Omnibuses.

The Electrobus a Success in London. Illustrated description of mechanical equipment and summary of cost of operation. 1000 w. Com Veh—Oct., 1908. No. 95576.

Peugeot.

The 12-16 H.P. Live-Axle Peugeot Car. Illustrated detailed description. 2000 w. Autocar—Oct. 17, 1908. No. 96045 A.

Taximeters.

The Mechanism of a Taximeter. J. F. Gairns. Detailed description of "Aron" taximeter as fitted by the Gen. Elec. Co., Ltd., of London. Illus. 2000 w. Cassier's Mag—Oct., 1908. No. 95661 B.

Tractors.

Tests of a Lanz Superheated Steam Locomobile with Lentz Valves (Leistungsversuche an einer Lanzschen Heizdampf-Locomobile mit Ventilsteurung, Bauart Lentz). E. Josse. Describes, and reports tests on, a 140-170 horse power tractor. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Sept. 12, 1908. No. 96193 D.

Wheel Slip.

Wheel Slip at the Road. Description of Experiments by S. F. Edge on Brooklands Track to determine amount of slip at the point of contact between the road and the wheels. Ills. 800 w. Autocar—Oct. 3, 1908. No. 95888 A.

We supply copies of these articles. See page 579.

COMBUSTION MOTORS.

Compression.

The Utility of Compression in Combustion Motors (Sur l'Utilité de la Compression dans les Moteurs à Explosion). L. Lecornu. A theoretical explanation. Ills. 1700 w. Rev de Mécan—Sept., 1908. No. 96110 E + F.

Fuels.

Fuel for Power Generation. Edward C. Warren. Gives radical suggestions for a departure from the "carbon cycle." 4500 w. Engineering Magazine—Nov., 1908. No. 96207 B.

Gas Cleaning.

Sulphur in Gaseous Fuels. F. Louis Grammer. Notes on blast-furnace gas, producer gas, and the removal of sulphur. 700 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95473 C.

Gas-Engine Foundations.

Concrete Foundations for Gas Engines H. M. Nicholls. The fundamental principles of such foundations are discussed. Ills. 3000 w. Gas Engine—Oct., 1908. No. 96084.

Gas Engines.

The Temperature of the Walls of a Gas-Engine Cylinder. E. G. Coker. A report of experimental work and results. 2500 w. Engng—Oct. 16, 1908. No. 96054 A.

Buckeye Gas Engine. Illustrated account of a new four-cycle type gas engine. 1400 w. Elec Ry Jour—Oct. 3, 1908. No. 95596.

Large Gas Engine for Fuel of Low Calorific Value. Illustrated description of double-acting two-cycle gas engine of 1,300-1,500 h.p. for a German copper works, built by the M. A.-G. v. Gebrüder Klein. 1000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95858 A.

See also same title, under MARINE AND NAVAL ENGINEERING.

Gasoline Turbines.

Some Possibilities of the Gasolene Turbine. Frank C. Wagner. Compares methods of reducing the temperature of the gases and considers how such comparison is affected by variations in the efficiencies of the turbine and air compressor. 2500 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96041 F.

Gas Power Plants.

Power Plant Operation on Producer Gas. Discussion of a paper by Godfrey M. S. Tait. Illus. 1500 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95603 F.

Suction Gas Producer Power. L. P. Tolman. Reviews the development, the government tests and the advantages, illustrating and describing a power plant. 4500 w. Pro Age—Oct. 1, 1908. No. 95501.

A Large Suction Gas Producer Power Plant. Illustrated description of a large plant at Beloit, Wis., with reference to special features of engine and producer design. 1600 w. Power—Oct. 27, 1908. No. 96069.

Gas Producers.

In Defense of the Gas Producer. Frank P. Peterson. Remarks on early designs, rating, etc. 2000 w. Power—Sept. 29, 1908. No. 95456.

The Reliability of the Producer Gas Plant. Thos. L. White. Defines conditions of reliability and discusses various tests. 2500 w. Cassier's Mag—Oct., 1908. No. 95665 B.

Bituminous Producer Plants. Elbert A. Harvey. Illustrated discussion of updraft producers where the heavy hydrocarbons are removed in a rotary gas washer. 10000 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95605 F.

Gas Producers for Bituminous Coal. Oskar Nagel. Describes various producers designed to burn coals having much volatile matter. Illus. 1000 w. Cassier's Mag—Oct., 1908. No. 95660 B.

Loss of Fuel Weight in a Freshly Charged Producer. N. T. Harrington. Gives results of a test to determine the relation between the coal fired and actually consumed. Illus. 1200 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95604 F.

The Production of Cheap Power by Suction Gas Plants. Philip W. Robson. A paper read before Section G of the British Association at Dublin; discusses costs and operation of a suction producer plant. Ills. 6000 w. Elect'n, Lond—Sept. 25, 1908. No. 95778 A.

Further Experiments Upon Gas Producer Practice. W. A. Bone and Richard Vernon Wheeler. A paper read before the Iron & Steel Institute describing a method for obtaining a rich gas of high carbonic-oxide content for either power or heating. 10000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95856 A.

Design for a 25-Horse-Power Gas Producer. F. C. Tryon. Instructions and specifications of the materials. Ills. 2000 w. Power—Oct. 20, 1908. No. 95969.

Gas Turbines.

Explosion or Combustion Gas Turbines (Explosions-Gasturbine oder Verbrennungs-Gasturbine)? Dr. Wegner-Dallwitz. A comparative discussion of the two types. Serial. 1st part. 1600 w. Die Turbine—Sept. 20, 1908. No. 96179 D.

Oil Engines.

See Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

HEATING AND COOLING.

Fans.

Tests on a 35-Inch Exhaust Fan. Charles H. Chase. Gives results of tests made to determine to what extent the loss of power may be decreased by using

ball bearings. Ills. 1500 w. Power—Sept. 29, 1908. No. 95454.

Gas Heating.

Modern Methods of Heating. H. R. Basford. Read before the Pacific Coast Gas Assn. Especially considers the automatic gas water heater. 3000 w. Am Gas Lgt Jour—Oct. 19, 1908. No. 95908.

Hot-Air Heating.

Mechanical Furnace Heating in a Residence. Describes an unusual installation with large fan and trunk air pipes. 3000 w. Met Work—Oct. 3, 1908. No. 95909.

Hot-Water Heating.

Indirect Hot Water Radiation in a Large Residence. Illustrated description of work, explaining a method of determining sizes. 4500 w. Met Work—Oct. 24, 1908. No. 96028.

Some Facts and a Few Theories Concerning the Operation of a Central Station Hot Water Heating and Electrical Generating Plant. J. D. Hoffman. Describes a successful plant, giving facts relating to its operation. 2500 w. Heat & Vent Mag—Oct., 1908. No. 96088.

Self-Regulation of Hot-Water Heaters (Ueber die Selbstregulierung von Warmwasserheizkörpern). P. Hase. A discussion of the conditions under which it is successful. Ills. 7700 w. Gesundheits-Ing—Sept. 19, 1908. No. 96172 D.

Damage Caused by Water Containing Air in Central Heating Plants (Die Zerstörungstätigkeit lufthaltigen Wassers in Zentralheizungen). Paul Pakusa. Discusses the corrosion of boiler tubes and water pipes. 3300 w. Gesundheits-Ing—Sept. 12, 1908. No. 96171 D.

See also Station Heating, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Refrigeration.

The First International Congress of Cold. A report of the meeting at Paris to consider modern requirements and methods of this industry. 3500 w. Engng—Oct. 16, 1908. Serial. 1st part. No. 96057 A.

Proposals Submitted to the Congress Concerning the Standardization of Refrigerating Measures and the Trial Methods of Refrigerating Machines. Maurice Lablanc. Read before the 1st Int. Cong. of Refrig. Ind. at Paris. Deals with the choice of units, and the capacity, efficiency and testing of refrigerating machines. 7000 w. Cold Storage & Ice—Oct., 1908. No. 96065 C.

Apartment House Refrigeration. Illustrated account of a refrigerating plant in the Lessing Apartments, Chicago, installed in 1898. 1300 w. Ice & Refrig—Oct., 1908. No. 95611 C.

A New Ice-Making Machine for Domestic Use. Illustrated description of a simple machine invented by Audiffren of Paris which can be operated by a small motor. 1500 w. Sci Am—Oct. 17, 1908. No. 95893.

Busy Bee Candy Factory and Bakery. Detailed description of refrigerating and freezing plant for candy and ice cream factory, bakery, ice making system and restaurant. Diagrams and other illustrations. 3200 w. Ice & Refrig—Oct., 1908. No. 95612 C.

Ventilation.

Systems of Mechanical Ventilation and Refrigeration for the Carnegie Safe Deposit Co.'s Vaults. J. Byers Holbrook. Illustrated description of the system of ventilation designed to insure a constant supply of fresh cool air and removal of vitiated air. 2200 w. Am Archt—Oct. 14, 1908. No. 95903.

Methods of Testing the Efficiency of Ventilation. Ellen H. Richards, E. Marion Wade, Royce W. Gilbert, Carl E. Hanson, James M. Talbot. Describes methods of ascertaining the quality of air in rooms, shops, etc., which are sufficiently reliable, giving some results. Ills. 2500 w. Tech Qr—Sept., 1908. No. 96077 E.

The Heating and Ventilation of Restaurants and Cafés (Die Heizung und Lüftung von Restaurationen und Cafés). H. Roose. Outlines the general principles on which plants should be designed. 2200 w. Gesundheits-Ing—Sept. 5, 1908. No. 96170 D.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

A High-Duty Turbine Pump. General description of tests made by James E. Denton. 2000 w. Can Engr—Oct. 16, 1908. No. 95906.

A High Efficiency Turbine Pump. Illustrated account of La-Degen 2-stage centrifugal pump with result of tests by James E. Denton, of Stevens Institute. 2240 w. Ir Trd Rev—Oct. 8, 1908. No. 95886.

The Choice and Examination of Centrifugal Pumps (Ueber die Auswahl und Beurteilung der Zentrifugalpumpen). P. Hartmann. A mathematical discussion of the selection and design of a pump for given conditions. Ills. 3500 w. Glückauf—Sept. 12, 1908. No. 96148 D.

See also Electric Pumping, under HYDRAULIC MACHINERY.

Electric Pumping.

Electric Pumping at the Duluth Waterworks. Illustrated description of a high efficiency centrifugal pump plant of 13,000,000 gallons capacity. Comparative cost of steam and electric pumping. 1000 w. Elec Wld—Oct. 10, 1908. No. 95872.

Orifices.

See same title, under CIVIL ENGINEERING, WATER SUPPLY.

Piping.

See Steam Pipes, under STEAM ENGINEERING.

We supply copies of these articles. See page 579.

Pump Capacity.

Determining the Capacity of a Power Pump. W. H. Wakeman. Gives a practical method of calculating displacement and delivery. 1500 w. Power—Oct. 27, 1908. No. 96068.

Pumping Engines.

Tests of Screw Pumping Engines at Chicago. Describes the official duty tests made recently on the engines in the 39th St. sewage pumping station. Ills. 3000 w. Eng Rec—Oct. 17, 1908. No. 95930.

Surge Tanks.

Surge Tanks in Water Power Plants. Discussion of a paper by Raymond D. Johnson. Illus. 25000 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95599 F.

Turbine Plants.

Water-Power Plants by the Combined Kander and Hagnek Companies, Bern (Wasserkraftanlagen der Vereinigten Kander- und Hagnek A.-G. in Bern). The first part of the serial describes the hydraulic installation at the Speiz electric plant. Ills. Serial. 1st part. 2500 w. Schweiz Bau—Sept. 12, 1908. No. 96152 D.

Hydraulic Installations of the Société Romande d'Electricité, at Aigle, Vouvry and Montreux (Installations hydrauliques créées par la Société romande d'électricite, à Aigle, Vouvry et Montreux). J. Michaud. Illustrated description of these important Swiss plants. Serial. 1st part. 2300 w. Bul Tech d l Suisse Romande—Sept. 25, 1908. No. 96120 D.

Turbine Testing.

Brake Tests of Hydraulic Turbines. C. Everett Quick. Describes methods of testing with brakes having disk friction plates. Ills. 1800 w. Eng News—Oct. 18, 1908. No. 95746.

Valves.

Influence of Valves on the Flow of Water. Fred Pillmore. Discusses the effect the amount of closing of a valve has on the flow of water. Ills. 700 w. Power—Oct. 13, 1908. No. 95835.

Water Wheels.

The Form of Tangential Buckets (Die Tangentialschaufelform). Otto Graf. Illustrates and discusses the form of bucket employed by various makers. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 20, 1908. No. 96182 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

The Simplification of Ball Bearings (Vereinfachungen in den Kugellagerungen). August Bauschlicher. A discussion of their standardization for automobiles. Ills. 4000 w. Zeitschr d Mit Motorwagen Ver—Sept. 15, 1908. No. 96166 D.

Cams.

Method of Laying Out Cutting Cams. Herbert C. Barnes. Discussion of the method of laying out a cam and description of a process for making the master cam. Ills. 2000 w. Mach, N Y—Oct., 1908. No. 95720 C.

Clutches.

Clutches. Discussion of a paper by Henry Souther. Ills. 1400 w. Jour Am Soc Mech Engrs—Oct., 1908. No. 95600 F.

Crankshafts.

Designing and Fitting Crankshafts. H. S. Brown. Discusses good and bad design and construction. Ills. 2500 w. Ir Age—Oct. 22, 1908. No. 96003.

Drills.

The Design of Twist Drills. A. T. Weston. Explains the principles involved, discussing the extent to which they can be put in practice. 2500 w. Engr, Lond—Sept. 18, 1908. No. 95409 A.

Gears.

Diagrams for Designing Spiral Gears. Francis J. Bostock. Describes a graphical method for designing spiral gears. Diagrams. 1800 w. Mach, N Y—Oct., 1908. No. 95718 C.

Truth About the Hindley Worm and Wheel. Oscar J. Beale. A discussion of the tooth contact, showing that they bear in every groove of worm. Ills. 1800 w. Am Mach—Vol. 31, No. 40. No. 95507.

A Note on the Design of Gear Wheels (Beiträge zur Berechnung der Zahnräder). Emil Vidéky. A mathematical discussion of deformation stresses, etc., and the method of design. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—Sept. 4, 1908. No. 96173 D.

Graphical Charts.

The Construction of Graphical Charts. John B. Peddle. Considers their use and construction. 3800 w. Am Mach—Vol. 31. No. 44. No. 96210.

The Laying Out and Use of Calculating Charts. T. B. Morley. Description of various charts for solving engineering problems, with plates showing specimen charts. 5000 w. Trans Inst Eng & Ship in Scot—Vol. 51, Feb. 4, 1908. No. 95609 N.

Link Motions.

A Link Motion Designed and Analyzed. Frank W. Merrill. Describes a method for use in the drafting room and explains the action of the link. Ills. 5600 w. Power—Oct. 6, 1908. No. 95831.

MACHINE WORKS AND FOUNDRIES.

Brass Founding.

The Use of a Chloride of Zinc Flux in Melting Aluminum and Its Alloys. Describes the use of this flux and its good effect. 1300 w. Brass Wld—Oct., 1908. No. 96082.

Case Hardening.

Case-Hardening by Means of Gas. Illustrations of Machlet's plant for case-hardening by carburizing gas, with brief description. 350 w. Engng—Oct. 9, 1908. No. 95991 A.

We supply copies of these articles. See page 579.

Castings.

Warped or Distorted Castings—Methods of Prevention. Jabez Nall. Discusses the causes and remedies. Ills. 1800 w. Foundry—Oct., 1908. No. 95802.

Production of Pump Castings. Wm. Roxburgh. Discussion of molds, cores, and method of manipulation. Ills. 1800 w. Foundry—Oct., 1908. No. 95800.

Making Fine Detail Castings in Sand. Walter J. May. Suggestions for fine detail work. 1200 w. Prac Engr—Oct. 2, 1908. No. 95899 A.

Engineering Castings. Arthur Caddick. Describes the constituents of cast-iron and their effects. Ills. 1500 w. Prac Engr—Oct. 9, 1908. Serial. 1st part. No. 95979 A.

Chain Making.

Borsig Chains and Shackles (Borsigketten und Kenterschäkel). Max Krause. An illustrated description of the method of making Borsig chains and a discussion of their advantages. 3000 w. Stahl u Eisen—Sept. 23, 1908. No. 96142 D.

Cupolas.

Cupola Construction and Operation. Thos. D. West. A paper read before the New England Foundry Men's Assn. Discusses conditions of operation and repairs. 3000 w. Foundry—Oct., 1908. No. 95801.

Foundries.

A Modern Steel Foundry and Machine Shop. C. A. Tupper. Illustrated description of a large steel foundry for the making of general castings, at Milwaukee, Wis. 3500 w. Elec-Chem & Met Ind—Oct., 1908. No. 95459 C.

The Ehrhardt & Sehmer Foundry in Schliefmühle-Saarbrücken (Die Giesserei der Firma Ehrhardt & Sehmer, G. m. b. H., in Schleifmühle-Saarbrücken). J. Treuheit. Illustrated description of a large and well equipped plant for the production of heavy castings. Serial. 1st part. 2800 w. Stahl u Eisen—Sept. 2, 1908. No. 96136 D.

Foundry Furnaces.

The Application of the Electric Furnace in the Foundry (Die Verwendung des elektrischen Ofens in der Giesserei). A general discussion, referring in the first part to Moldenke's advocacy of the electric furnace. Serial. 1st part. 1200 w. Elektrochem Zeitschr—Sept., 1908. No. 96135 D.

Foundry Materials.

Grading Pig Iron, Alloys and Coke. A classification prepared by Eliot A. Kebler, manager of sales of Matthew Addy & Co., Cincinnati. 4800 w. Foundry—Oct., 1908. No. 95803.

Foundry Practice.

Gaging Metal in Steel Ladles. Joseph Bretaud. Table giving the weight of steel in ladles at varying depths and discussion of methods employed in constructing the table. Tables. 1300 w. Foundry—Oct., 1908. No. 95797.

Furnaces.

Heat Treating Furnaces and Their Location. Illustrated description of the annealing, hardening, tempering and carbonizing furnaces of the Chicago Flexible Shaft Co. 1200 w. Am Mach—Vol. 31. No. 42. No. 95948.

Heating and Melting Furnace Work. Ulrich Peters. Considers shape, brick and methods of calculating requirements. 1700 w. Ir Age—Oct. 15, 1908. No. 95915.

Gear Cutting.

4-Ft. 6-In. Universal Gear-Cutting Machine at the Franco-British Exhibition. Joseph Horner. Illustrated detailed description of the machine and its operations. 2500 w. Engng—Oct. 16, 1908. No. 96058 A.

Jigs.

Jigs for Machining an Oil Pump Body. A. J. Baker. Describes tools designed for expeditious manufacture of geared oil pumps. Ills. 1500 w. Am Mach—Vol. 31. No. 43. No. 96007.

Lathes.

Railway Axle Lathe. Illustrated description of an English lathe for turning the ends of railway, wagon and carriage axles. 600 w. Engng—Sept. 18, 1908. No. 95418 A.

Machine Tools.

Historic Machinery. W. J. Blackmur. Illustrated descriptions of a metal planer, and a screw-cutting lathe in the Patent Museum, England. 1200 w. Ir Age—Oct. 15, 1908. No. 95914.

Some Machine Tools Built in English Shops. Joseph G. Horner. Illustrates and describes tools of recent design shown at the Franco-British exhibition. 4000 w. Am Mach—Vol. 31. No. 41. No. 95941.

Milling Machines.

Horizontal Boring, Tapping, and Milling Machine. Illustrated description of a very heavy machine constructed by De Fries & Co. of Dusseldorf. Plates. Engng—Sept. 25, 1908. No. 95646 A.

Molding.

Molding a Large Gear Wheel. W. W. Carter. Drawings and description. 600 w. Am Mach—Vol. 31. No. 42. No. 95946.

Molding a Cast Steel Cylinder. H. T. McCaslin. Discusses the construction of a mold for a cast steel hydraulic cylinder. Ills. 2100 w. Foundry—Oct., 1908. No. 95804.

The Molding of Locomotive Cylinders. Louis Luhrsen. Description of methods of overcoming imperfections and making the patterns and metal mixtures. Ills. 2200 w. Foundry—Oct., 1908. No. 95798.

Molding Machines.

Molding Machines for Large Work.

We supply copies of these articles. See page 579.

Describes use of jarring machines in the plant of the Filer and Stowell Co. Ills. 1200 w. Foundry—Oct., 1908. No. 95796.

Molding Machines for Machine Tool Castings. John Edgar. Considers the kind of machine adapted to this work, etc. Ills. 2000 w. Am Mach—Vol. 31. No. 40. No. 95508.

Pattern Shops.

The Pattern Shop Store Room. Oscar E. Perrigo. Discusses the proper conduct of this department and methods of charging lumber and supplies. Ills. 3500 w. Foundry—Oct., 1908. No. 95799.

Planers.

Method of Leveling and Alining Planers. James J. Thompson. Illustrated description of the methods employed in the shops of the Am. Tool Works Co. 1800 w. Am Mach—Vol. 31. No. 43. No. 96005.

Rigidity Test of a 24 x 24-Inch x 8-Foot Planer. James A. Pratt. Outlines a test made of the amount of spring in the machine when making heavy cuts and using a high-speed steel cutting tool. Ills. 4500 w. Am Mach—Vol. 31. No. 42. No. 95944.

Sand Blast.

Foundry and Pattern Shop Equipment. Discusses sand blast equipment, for treating small castings. Ills. 1300 w. Foundry—Oct., 1908. No. 95805.

The Jorn Sand Blast Apparatus. Illustrated account of a new continuous acting machine for metal and glass workers. 900 w. Ir Age—Oct. 8, 1908. No. 95879.

Shop Design.

Design and Construction of Metal-Working Shops. Discusses arrangement of plant and describes typical shops. Ills. 5500 w. Mach, N Y—Oct., 1908. No. 95717 C.

Shop Heating.

Shop Heating and Ventilation. Illustrated description of a system used in the Abendroth & Root Mfg. Co.'s plant at Newburgh, N. Y. 1500 w. Ir Age—Oct. 22, 1908. No. 96000.

The Heating and Ventilating of Machine Shops. Illustrates and describes two heating plans, affording examples of the direct air-heated and steam air-heated systems. 2000 w. Engr, Lond—Oct. 16, 1908. No. 96063 A.

Shop Hygiene.

Lockers, Wash and Bath Rooms for Shops and Manufactories (Vestiaires, Lavabos et Bains pour les Usines et Ateliers). Henri Mamy. Describes typical appliances and arrangements. Ills. 2500 w. Génie Civil—Sept. 5, 1908. No. 96122 D.

Shops.

A Modern Lamp-Making Works. An interesting description of the new factory of the Westinghouse Lamp Company at Watsessing, N. J. Ills. 2800 W. Elec Rev—Oct. 3, 1908. No. 95883.

The Works of Cammell Laird & Company, Limited. Illustrated description of works for iron and steel manufacture. 1500 w. Ir & Coal Trds Rev—Oct. 9, 1908. No. 95997 A.

See also Foundries, under MACHINE WORKS AND FOUNDRIES.

Steam Hammers.

The Steam Hammer and Its Use. James Cran. Describes most practical method for its use. Ills. 2500 w. Mach, N Y—Oct., 1908. No. 95721 C.

A New Steam Hammer Design. Drawings and description of a combined handing and self-acting type, with improved controlling gear. 1600 w. Mech Engr—Sept. 18, 1908. No. 95429 A.

Welding.

Art and Science of Autogenous Welding. E. S. Foljambe, before the Soc. of Auto. Engrs. Discusses oxy-acetylene autogenous welding and its applications and cost. 1800 w. Boiler Maker—Oct., 1908. No. 95483.

Schaap Autogenous Welding Process. Describes burner and apparatus and some of the work done. Ills. 1200 w. Am Mach—Vol. 31. No. 42. No. 95947.

The Oxy-Acetylene Process of Cutting and Welding Metals. Illustrated account of application of this process to the repair of locomotives and other railway equipment. 2200 w. Ry & Engng Rev—Oct. 3, 1908. No. 95673.

Oxy-Acetylene Process of Metal Cutting and Autogenous Welding. Describes use of the oxy-acetylene torch in mechanical operations. Mach, N Y—Oct., 1908. No. 95722 C.

See also Locomotive Repairs, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Woodworking Machines.

Accidents with Planing Machines and the Carstens Shaft (Les Accidents occasionnés par la "Dégauchisseuse," et "l'Arbre Carstens"). A. Beauquis. The danger to workmen in planers with square shafts, safety devices, and the advantages of the Carstens cylindrical shaft. Ills. 4000 w Rev d'Econ Indus—Sept. 16, 1908. No. 96100 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Influence of Silicon on Iron. Adolph Jouve. Read before the I. and S. Inst. Considers its influence on the physical and chemical properties of iron. 1500 w. Engng—Oct. 16, 1908. No. 96060 A.

Influence of Silicon on the Physical and Chemical Properties of Iron. Adolphe Jouve. A paper presented to the Iron & Steel Institute dealing especially with the diminishing of the magnetic properties and the increased resistance to the action of acids. 3500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95850 A.

We supply copies of these articles. See page 579.

Magnalium: Its Strength, Weight and Uses. Rules for molding, forging, rolling, and machining. Ills. 2000 w. Am Mach—Vol. 31. No. 41. No. 95942.

Brass.

The Effect of Impurities on Brass Intended for Rolling. Erwin S. Sperry. A résumé indicating the effect of the various metallic and non-metallic elements. 4000 w. Mech Engr—Oct. 16, 1908. No. 96050 A.

Brass Analysis.

The Complete Analysis of Brass. Albert J. Hall. Gives details of analysis in full. 5000 w. Elec-Chem & Met Ind—Nov., 1908. No. 96094 C.

Cast Iron.

Castings versus Forgings. James H. Baker. Discusses the development of the respective fields of cast and wrought iron and steel. Ills. 2500 w. Ir Age—Oct. 1, 1908. No. 95505.

Copper.

A Relation Between the Hardness, Limit of Stretching Strain, and Internal Energy of Ductile Metals (Eine Beziehung zwischen Härte, Streckgrenze und der inneren Energie zäher Metalle). Alfred Kürth. A discussion based on the results of tests on copper. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 26, 1908. No. 96196 D.

Heat Insulation.

See Packings, under MATERIALS OF CONSTRUCTION.

Malleable Iron.

Malleable Cast Iron: Its Evolution and Present Position in the Metallurgical World. W. H. Hatfield. Paper and Discussion. Ills. 7000 w. Trans Inst Eng & Ship in Scot—Vol. 51, March 17, 1908. No. 95605 N.

Metallography.

Metallography Applied to Engineering. William Campbell. On the methods of microscopic examination of metals and the use of the knowledge obtained to engineers. Ills. 5000 w. Jour Can Min Inst—1908. No. 96248 N.

Note on a Workshop Microscope. J. E. Stead. Read before the I. and S. Inst. Describes a simple instrument for examining metals and alloys. Ills. 1000 w. Engng—Oct. 2, 1908. No. 95715 A.

The Freezing Point of Iron. H. C. H. Carpenter. A paper read before the Iron and Steel Institute giving a résumé of pyrometric measurement of the freezing point of iron and summary of results. 3700 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95849 A.

The Constitution of Carbon Steels. E. D. Campbell. A paper read before the Iron & Steel Institute which discusses the chemical composition. 7000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95852 A.

Gas Occluded in a Special Nickel Steel (Gaz occlus dans un Acier au Nickel Spécial). M. G. Belloc. Gives the result of researches carried out by the author. Ills. 1000 w. Rev de Métal—Sept., 1908 No. 96105 E + F.

An Optical Method for the Determination of the Hardness of the Constituents of Alloys (Méthode optique pour la Détermination de la Dureté des Constituants des Alliages). M. Ziegler. Describes the method and its application to iron-sulphur alloys. Ills. 1700 w. Rev de Métal—Sept., 1908. No. 96104 E + F.

Packings.

Packings and Heat-Insulating Materials (Ueber Dictungen, Packungen und Wärmeschutzeinrichtungen im Maschinenwesen). Herr Tanneberger. Describes various materials, their uses, and methods and appliances for applying them to various classes of machinery. Ills. Serial. 1st part. 5500 w. Glasers Ann—Sept. 1, 1908. No. 96184 D.

Rubber.

The International Rubber Exhibition at Olympia. An account of the exhibits. 2500 w. Engng—Sept. 18, 1908. No. 95419 A.

Wrought Iron.

See Cast Iron, under MATERIALS OF CONSTRUCTION.

MEASUREMENT.

Averaging Instruments.

An Averaging Instrument for Polar Diagrams. W. F. Durand. A description of the instrument and its use. 1500 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96039 F.

Chain Testing.

An Up-to-Date German Chain-Testing Plant. Alfred Gradenwitz. Illustrates and describes the plant and methods at the Borsig works. 1000 w. Am Mach—Vol. 31. No. 43. No. 96006.

Dynamometers.

Development of the Alden Absorption Dynamometer. G. Everett Quick. Illustrated description. 700 w. Elec Wld—Oct. 31, 1908. No. 96214.

Gages.

Constant and Progressive Tolerances for Gages. C. E. Johansson. On the importance of gaging systems, the difficulties, etc. 2000 w. Am Mach—Vol. 31, No. 41. No. 95940.

The Calibrating of Twelve Ames Dial Gages. Walter Gribben. An account of the method and the results. Ills. 1200 w. Am Mach—Vol. 31. No. 42. No. 95945.

Hardness.

The Ball Method of Testing Hardness as a Means of Estimating Resistance to Rupture (Evaluation de la Dureté par la Méthode de la Bille considérée comme Mesure de la Résistance à la Rupture). A. Kürth. A mathematical discussion based on tests. Ills. 5000 w. Rev de Mécan—Sept., 1908. No. 96109 E + F.

We supply copies of these articles. See page 579.

Propeller Testing.

Testing of Airship Propellers in the Testing Laboratory of the Conservatoire National des Arts et Métiers (Essai des Hélices Aériennes au Laboratoire d'Essais du Conservatoire National des Arts et Métiers). M. Boyer-Guillon. A mathematical description of method, giving results. Ills. 3000 w. Rev de Mécan—Sept., 1908. No. 96108 E + F.

Pyrometry.

Technical Thermometer. J. H. Hart. Considers especially the types of thermometers available for utilization in molding and casting of different metals, their principles, advantages, operation, cost, etc. 2500 w. Elec-Chem & Met Ind—Nov., 1908. No. 96096 C.

The Measurement of Temperature (La Misura della Temperature). Ugo Bordoni. A general review of thermometric and pyometric methods and apparatus. Ills. Serial. 2 parts. 10500 w. Ann d Soc d Ing e d Arch Ital—Aug. 15 and Sept. 1, 1908. No. 96132 each F.

Tachometers.

Liquid Tachometers. Illustrates and describes the Veeder tachometer, its operation, construction and method of testing. 3500 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96037 F.

Testing Machines.

Reverse-Torsion Testing-Machine. Brief illustrated description. 700 w. Engng—Oct. 10, 1908. No. 95992 A.

Testing Machines at the Glasgow Technical College. Descriptive of new machines including a 100-ton horizontal testing machine, a tension-torsion machine and a reverse-torsion testing machine. Ills. 2400 w. Engng—Sept. 25, 1908. No. 95639 A.

See also Rails, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Testing Methods.

Torsion Tests (Essais de Torsion). Pierre Breuil. Discusses torsion tests as a basis for the selection of metals, and the relation between torsion and tension, giving results of comparative tests. Ills. 6300 w. Bul d Lab d'Essais—No. 14. No. 96103 N.

Standards and Specifications for the Testing and Acceptance of Iron Materials (Norme e Condizioni per le Prove e per l'Accettazione dei Materiali ferrosi). The test of the specifications of the Italian Soc. of Engrs. & Architects. Ills. 5000 w. Ann d Soc d Ing e d Arch Ital—Sept. 1, 1908. No. 96133 F.

POWER AND TRANSMISSION.

Air Compression.

Air Compression at High Altitudes. S. B. Redfield. Discusses reasons for greater quantity of compressed air at greater pressure and considers power required. Ills. 3000 w. Power—Oct. 6, 1908. No. 95829.

Air Compressors.

A Novel Hydraulic Air Compressor. Describes the invention of George C. MacFarlane. Ills. 1100 w. Compressed Air—Oct., 1908. No. 96087.

Air Compressors. C. S. Vesey Brown. General review of types of machine now on the market and description of chief characteristics. 4000 w. Cassier's Mag—Oct., 1908. No. 95662 B.

Chain Driving.

Chain Driving. Discussion of the advantages of chain driving as shown by tests in the factory of Hans Renold, Ltd., Manchester, in comparison with belt drive. Ills. 2500 w. Mech Engr—Sept. 25, 1908. No. 95891 A.

Electric Driving.

Some Notes on Electric Driving. Theodore Parsons. Describes installations for electric driving and advantages of the system. 6000 w. Trans Inst Eng & Ship in Scot—Vol. 51, March 3, 1908. No. 95610 N.

Electric Drive for Metal Working Shops. Norman G. Meade. Discussion of essential factors and advantages and consideration of various types of motors. Ills. 1700 w. Power—Oct. 6, 1908. No. 95826.

See Textile Mills, under MISCELLANY; and Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Power Plants.

Breakdowns of Power Plant Machinery. Extract from the Annual Report of Michael Longridge, Inspector for the British Engine, Boiler and Electrical Insurance Co. Ills. 4500 w. Power—Oct. 13, 1908. No. 95841.

Electricity in the Production of Spelter and Sulphuric Acid. Describes a plant at Danville, Ill., which treats concentrated ore from the Joplin fields. Ills. 1500 w. Elec Rev, N Y—Oct. 10, 1908. No. 95723.

The Power Plant of the Falk Company, Milwaukee, Wis. Illustrated description of a large plant where machinery is operated by compressed air or electrically. 1600 w. Eng Rec—Oct. 3, 1908. No. 95622.

New Power Plant of the Pennsylvania R. R. Warren O. Rogers. Illustrates and describes the principal features of the installation at Ashtabula Harbor, Ohio, with special reference to the storage battery. 2000 w. Power—Sept. 29, 1908. No. 95453.

See also Textile Mills, under MISCELLANY.

STEAM ENGINEERING.

Air Pumps.

The Starting and Operation of Air Pumps. G. H. Gibson. General discus-

sion. Ills. 1500 w. Power—Oct. 6, 1908. No. 95827.

Boiler Design.

Bracing Flat Surfaces in Steam Boilers. Discusses the causes of deformation, washout holes and their location, effects of deformation on the stays, purpose of head and nuts on stays. 2000 w. Boiler Maker—Oct., 1908. No. 95480.

Boiler Furnaces.

Furnace Design in Relation to Fuel Economy. E. G. Bailey. Read before the Boston Soc. of Civ. Engrs. Briefly considers the losses affecting the heat value. 2500 w. Boiler Maker—Oct., 1908. No. 95479.

For Burning Shavings and Sawdust. Orosco C. Woolson. A discussion of the best methods for burning shavings and sawdust and the furnaces best suited for this purpose. Ills. 1800 w. Power—Oct. 13, 1908. No. 95838.

Boiler Management.

The Emptying and Cooling of Boilers. Remarks on the best methods, showing the need of care. 1500 w. Prac Engr—Oct. 9, 1908. No. 95980 A.

The Scientific Control of Fuel Consumption. Henry E. Armstrong. A paper read before the British Iron & Steel Institute which discusses the exhaustion of the coal supply and means for its control. 4300 w. Col Guard—Oct. 2, 1908. No. 95866 A.

The Heating of Air by Flue-Gases. George Edward Tansley. Describes a series of experiments to determine the most suitable form of tube and heater for the utilization of the heat in flue-gases. Ills. 2500 w. Inst of Civ Engrs—No. 3681. No. 95498 N.

Boiler Settings.

Recent Improvements in Boiler-Setting in Great Britain. Improvements in methods of testing boiler-flue gases have led to better practice in furnace construction, etc. 1500 w. Boiler Maker—Oct., 1908. No. 95482.

Boiler Tubes.

The Slipping Point of Rolled Boiler Tube Joints. O. P. Hood and G. L. Christensen. Information concerning the behavior of such joints. Ills. 1600 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96040 F.

Boiler Waters.

Feed Water Practice in Western Australia. C. J. Mathews. Information concerning the kind of water that boiler owners must contend with and the best means of treating. 2500 w. Aust Min Stand—Sept. 16, 1908. No. 96228 B.

Water Softening and Practice at Broken Hill Proprietary. Leslie Bradford. An account of practice where the problem is more than usually difficult. 3000 w. Aust Min Stand—Sept. 23, 1908. No. 96229 B.

Condensers.

Air Leakage in Steam Condensers. Discussion of a paper by Thomas McBride. 2500 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95602 F.

The "Contraflo" System of Condensation. Describes a method for the regulation, within limits, of the volumetric efficiency of the air-pump by the control of its temperature. Ills. 1000 w. Engng—Oct. 2, 1908. No. 95711 A.

Condensers and Air Pumps. W. H. Booth. Discussion of a paper presented by M. Maurice Leblanc to the Association Technique Maritime of Paris. Considers vacuum conditions for steam turbines and reciprocating engines. 2200 w. Power—Oct. 6, 1908. No. 95832.

Design.

An Engineer's Notes on the Design of Steam Engines. Discusses designs to meet stated work and conditions. 1800 w. Mech Wld—Oct. 2, 1908. Serial. 1st part. No. 95901 A.

Determination of the Best Weight of Reciprocation of Parts in Steam Engine Design. E. L. Weber. A mathematical discussion of the best weights for high speed engines. Ills. 1700 w. Power—Oct. 6, 1908. No. 95828.

Engine Economy.

The Influence of Vacuum and Superheating on the Steamship Consumption of Reciprocating Engines and Turbines (Der Einfluss von Vakuum und Dampfüberhitzung auf den Dampfverbrauch von Kolbendampfmaschinen und Dampfturbinen). A. Rojinsky. Theoretical. Ills. Serial. 1st part. 2000 w. Die Turbine—Sept. 5, 1908. No. 96177 D.

Engine Governing.

Increasing the Power of an Engine. A. J. Dixon. Discusses the effect of changing the weight of the governor counterpoise in a Corliss engine. Ills. 2000 w. Power—Oct. 13, 1908. No. 95836.

Engines.

Design of an English High-Speed Steam Engine. Philip Bellows. Illustrated discussion of an engine of the semi-superposed type. 4500 w. Am Mach—Vol. 31, No. 43. No. 96008.

Engine Tests.

Economy Tests of High Speed Engines. Discussion of a paper by Messrs. Dean and Wood. Illus. 1500 w. Jour Am Soc Mech Engs—Oct., 1908. No. 95601 F.

History.

The Practical Evolution of the Steam Engine (Evolution pratique de la Machine à Vapeur). M. A. Mallet. An exhaustive historical discussion of the development of the steam boiler, superheating, surface condensers, steam jackets, and the theory of heat interchanges. Ills. 92000 w. Serial. 2 parts. Mem Soc Ing Civ de France—Aug. and Sept., 1908. No. 96102 each G.

We supply copies of these articles. See page 579.

Injectors.

Sellers' Non-Lifting 1908 Injector. Describes the results obtained by this recently brought out apparatus. 1800 w. R R Age Gaz—Oct. 30, 1908. No. 96239.

Automatic Injector Information. Frank O'Leary. General discussion with description of practical test of Penberthy automatic injector. Ills. 2200 w. Power—Oct. 6, 1908. No. 95833.

Smoke Prevention.

Smoke Prevention. Discusses the design of furnaces, and the proper firing to prevent smoke, and related subjects. 2000 w. Boiler Maker—Oct., 1908. No. 95481.

Steam Calorimetry.

A Method of Obtaining Ratios of Specific Heats of Vapors. A. R. Dodge. Describes a method, using the throttling calorimeter for determining the ratios, without using the steam tables. 2000 w. Jour Am Soc of Mech Engrs—Oct., 1908. No. 96038 F.

Steam Pipes.

Water Hammer in Pipes. S. K. Patteson. Explanation of the phenomenon and methods for its elimination in steam and water pipes. 2400 w. Power—Oct. 6, 1908. No. 95830.

Allowing for the Expansion of Steam Pipes. William D. Ennis. The effects of temperature rise are considered. An argument in favor of pipe bends. Ills. 3500 w. Power—Oct. 20, 1908. No. 95970.

The Piping System of High Pressure Plants. Charles L. Hubbard. Directions for arranging steam and water piping, showing the best methods for various conditions. 3500 w. Power—Sept. 29, 1908. No. 95455.

Steam Traps.

Steam Traps. Gordon Stewart. Deals with the principles upon which the various makes rely for their proper working, giving illustrations and descriptions of how these principles are employed. 2500 w. Elec Rev, Lond—Sept. 18, 1908. Serial. 1st part. No. 95439 A.

Stokers.

Chain Grate Stokers at Coventry. Illustrated description of the chain grate stokers and conveyors for handling fuel at the electricity station. 1700 w. Engr, Lond—Sept. 18, 1908. No. 95415 A.

Superheating.

See Engine Economy, under STEAM ENGINEERING.

Turbine Governing.

See Speed Regulation, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Turbines.

A Study of Low-Pressure Turbine Possibilities. Synopsis of a report by Ira R. Hollis on the plant of Cambridge Electric Light Co. 3500 w. Eng Rec—Oct. 3, 1908. No. 95614.

Exhaust Steam Turbine Results in Philadelphia and Scranton. Abstract of a paper by C. B. Burleigh on the low pressure steam turbine; gives power output and cost. 1500 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95677 C.

Development of the Double Flow Steam Turbine. R. N. Erhart. Description of the design and use of double flow turbines for generators of very large power and high speeds. Ills. Also editorial by B. G. Lamme. 1800 w. Elec Jour—Oct., 1908. No. 95844.

A Mammoth Turbine for Buenos Aires. Franco Tosi. Description of Parsons type of turbine with low-pressure Fullager compensator built by the Tosi firm. It develops 12,000 h.p. and operates on 13.86 lbs. of steam per kilowatt hour. Ills. 2800 w. Power—Oct. 13, 1908. No. 95834.

The Musgrave-Zoelly Steam Turbine. Illustrated account of the first Zoelly steam turbine made entirely in Great Britain, with section and elevation. Ills. 2200 w. Elect'n, Lond—Oct. 2, 1908. No 95781 A.

The Development of the Zoelly Turbine (Die weitere Entwicklung der Zoelly-Turbine). I. Weishäupt. Illustrates and describes turbines of this type by various makers, giving results of tests. 3900 w. Zeitschr d Ver Deutscher Ing—Sept. 5, 1908. No. 96191 D.

A Note on the General Turbine Theory (Beiträge zur allgemeinen Turbinen Theorie). Viktor Fischer. A mathematical discussion of systems of coördinates. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 10, 1908. No. 96180 D.

Graphical Calculation of a Multi-Stage Reaction Turbine (Graphische Berechnung einer vielstufigen Ueberdruckturbine). W. J. Jasinsky. Mathematical. Ills. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 20, 1908. No. 96181 D.

TRANSPORTING AND CONVEYING.

Coal Handling.

Recent Electric Discharging Plants (Neuere Verladebrücken mit elektrischem Antrieb). F. Janssen. Illustrated description of several large coal and ore hoists in Germany. 3000 w. Elek Kraft u Bahnen—Sept. 4, 1908. No. 96185 D.

Mechanical Conveying of Coal in the Rhein-Westphalian Mines (Maschinelle Fördereinrichtungen vor Ort auf rheinisch-westfälischen Gruben). Herr Forstmann. Describes the conveying devices used in several of the mines of this district. Ills. 5000 w. Glückauf—Sept. 5, 1908. No. 96147 D.

See also Barges, under MARINE AND NAVAL ENGINEERING.

Conveyors.

Handling Concrete with Belt Conveyors. Abstract from the Barge Canal Bul-

letin which describes the transportation of large quantities of mixed concrete. Ills. 1500 w. Eng Rec—Oct. 10, 1908. No. 95741.

Cranes.

The Design of Jib Cranes. R. W. Valls. A theoretical treatise of the typical crane and its construction from a commercial standpoint. Ills. 6000 w. Mach, N Y—Oct., 1908. No. 95719 C.

Electric Travelling Cranes in Car Maintenance. Illustrated account of repair work in the Cottage Grove Avenue car house of the Chicago City Railway Company. 1200 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95676 C.

New Car-Handling Crane in the Kansas City Shops. Illustrated description of a travelling crane whose carriage and hoist were improvised from materials on hand at the shops. 600 w. Elec Ry Jour—Oct. 3, 1908. No. 93588.

A Traveler for Viaduct Erection. L. L. Jewell. Describes a 15-ton traveler of unusual size and type and operated by electricity employed in erecting heavy single track viaducts. Ills. 1800 w. Eng News—Oct. 8, 1908. No. 95743.

Cranes at the German Marine Exhibition, 1908 (Zur Kranschau auf der deutschen Schiffbau-Ausstellung 1908). C. Michenfelder. Describes the models of heavy dock cranes exhibited. Ills. 4500 w. Deutscher Schiffbau—1908. No. 96162 N.

Crane Construction for Various Purposes (Kranbauarten für Sonderzwecke). C. Michenfelder. Illustrates and describes a large number of installations by German firms. Serial. 1st part. 2800 w. Zeitschr d Ver Deutscher Ing—Sept. 12, 1908. No. 96192 D.

Lifting Magnets.

Lifting and Loading Magnets for Steel Works. Brief description of Stuckenholz magnets for lifting and conveying small pieces. Ills. 800 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95859 A.

The Economy and Work of Lifting Magnets. E. F. Lake. Considers their many uses and the saving in labor. Ills. 2500 w. Am Mach—Vol. 31. No. 44. No. 96208.

Ore Handling.

A 1908 Iron Ore Handling Plant. Walter G. Stephan. Illustrated description of the new Hulett Machines at Central Furnaces, Cleveland, Ohio, consisting of two 10-ton automatic electric unloaders and one 10-ton ore handling bridge. 2400 w. Ir Age—Oct. 8, 1908. No. 95876.

MISCELLANY.

Aeronautics.

The Laws of Flight. F. W. Lanchester. Results of experiments and mathematical discussion. Paper read before Section of the British Association, Dublin, 1908. Ills. 4000 w. Engng—Sept. 25, 1908. No. 95647 A.

The Multiple Air Propeller. Its Aeronautic Possibilities for Dirigible Airships, Aeroplanes, and Helicopters. Description of two methods of using a number of small propellers of relatively low speed. Ills. 1200 w. Sci Am—Oct. 10, 1908. No. 95696.

Wright Aeroplane—A Noteworthy Invention. L. P. Alford. Illustrated description of the machine and an account of what it has accomplished. 2000 w. Am Mach—Vol. 31. No. 40. No. 95506.

French Purchase of the Wright Aeroplane. Remarks on what Mr. Wilbur Wright has accomplished, and the differences between his machine and French aeroplanes. Engr, Lond—Oct. 16, 1908. No. 96061 A.

Wilbur Wright Takes Passengers Aloft. W. F. Bradley. Brief account of aeroplane flights in France. Ills. 2000 w. Automobile—Oct. 22, 1908. No. 96021.

Experiments with the Langley Aeroplane. Dr. S. P. Langley. An article, written shortly before the writer's death, giving an account of pioneer experiments in aerial navigation. Ills. 5800 w. Pop Sci M—Nov., 1908. No. 96071 C.

See also Propeller Testing, under MEASUREMENTS.

Air Resistance.

Researches on the Resistance of the Air to Thin Plates, Parallel to Each Other and to the Direction of Motion (Versuche zur Ermittlung des Luftwiderstandes der Bewegungsrichtung parallelen Seitenflächen der Körper). Albert Frank. Describes the tests and gives a mathematical discussion of the results. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 19, 1908. No. 96195 D.

Fur Cutting Machinery.

Process of Fur Cutting. Gilbert E. Stetcher. Gives a sketch of the development of head gear and the fur cutting industry, illustrating machines used. 1500 w. Ins Engng—Oct., 1908. No. 96070 C.

Ice Harvesting Machines.

Harvesting Ice. Harold B. Wood. Illustrates and describes machines used in harvesting from one to three thousand tons of ice. 2500 w. Cold Storage & Ice—Oct., 1908. Serial. 1st part. No. 96066 C.

Monotype Machines.

Manufacturing the Monotype Keyboard. Illustrates and describes interesting methods and appliances used. 1400 w. Am Mach—Vol. 31. No. 41. No. 95939.

Nasmyth.

Nasmyth's Centenary. Reviews the engineering work of James Nasmyth. 3000 w. Engr, Lond—Sept. 18, 1908. Serial. 1st part. No. 95410 A.

Steel Pen Making.

Modern Methods of Making Steel Pens. Illustrated description of methods used at

the C. Howard Hunt plant, at Camden, N. J. 2000 w. Am Mach—Vol. 31. No. 43. No. 96009.

Textile Machinery.

Interesting Textile Machine Work. Illustrates and describes details of novel braiding machines. 1200 w. Am Mach—Vol. 31. No. 41. No. 95943.

Textile Mills.

Power Plants in Textile Mills. Notes from a paper by Lewis Sanders, read before the Nat. Assn. of Cotton Mfrs. 4000 w. Eng Rec—Oct. 17, 1908. No. 95934.

The Falcon Spinning Mill. Illustrated description of a plant at Halliwell near Bolton, England, where electric driving has been installed in a new mill. Ills. 3500 w. Elec Engng, Lond—Sept. 24, 1908. No. 95632 A.

Wire Covering Machines.

Novel Wire Covering Machinery. Illustrated account of machines for covering wire with cotton and polishing and enameling employed at the works of F. Hutchins & Co., Ltd., Harlesden. Ills. 1600 w. Elec Rev, Lond—Oct. 2, 1908. No. 95776 A.

MINING AND METALLURGY

COAL AND COKE.

Austria.

Austria's Supplies of Anthracite (Die Steinkohlenvorräte Oesterreichs). W. Petrascheck. A review of the various districts. Map. Serial. 1st part. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—Sept. 5, 1908. No. 96144 D.

Coking.

The Coke Yield of Anthracite (Ueber die Ermittlung der Koksausbeute von Steinkohlen). F. W. Hinrichsen and S. Taczat. Results of researches at the Imperial Testing Institute. 3300 w. Glückauf—Sept. 12, 1908. No. 96149 D.

Electric Power.

New Plant at the Penrikyber Navigation Colliery. Illustrated description of a new and extensive plant near Cardiff. The underground workings are being completely electrified. Ills. 4000 w. Ir & Coal Trds Rev—Sept. 24, 1908. No. 95634 A.

England.

The Eastern Extension of the Nottinghamshire and Yorkshire Coalfields. Walcot Gibson. Discussion of the geology of a concealed and virgin coal field where borings and sinkings have been made. Ills. 1200 w. Col Guard—Sept. 25, 1908. No. 95865 A.

Explosions.

Warrior Run Mine Accident. Describes conditions existing in this coal mine and gives verdict of coroner's jury. 1000 w. Mines & Min—Oct., 1908. No. 95629 C.

Illinois.

Majestic Coal & Coke Co.'s Mine at Clinch, Ill. R. S. Moss. Illustrated description of methods of mining and plant. 1400 w. Min Wld—Oct. 3, 1908. No. 95657.

Mine Dust.

The Coal Dust Experiments at Altofts. Illustrated description of additional experiments tending to confirm the theory that by the use of stone dust the effects of coal dust explosions may be confined to a comparatively limited area. 1300 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95861 A.

The Problem of Treating Dust in Coal Mines. Frank Haas. Read before the W. Va. Min. Assn. The writer's views differ from many. Also editorial. 5000 w. Eng & Min Jour—Oct. 24, 1908. No. 96032.

Spraying Coal Mines. D. Harrington. Account of pipe line construction for sprinkling system for Sunnyside No. 2 Mine, Carbon Co., Utah, with statement of cost. 3200 w. Mines & Min—Oct., 1908. No. 95625 C.

Mine Fires.

Sulphur Dioxide as an Agent in Fighting Mine Fires. Walter O. Snelling. Considers favorably its effectiveness and safety. 1000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95467 C.

Mine Floods.

Report on the Eruption of Water at Brereton Collieries. Information from the report of inspector, Hugh Johnstone, on the causes and circumstances attending the accident on Feb. 15, 1908. Ills. 3000 w. Col Guard—Sept. 18, 1908. No. 95421 A.

Mining.

Recent Developments and Future Problems in Colliery Working and Management. Presidential Address, Richard Landless, Lancashire Branch, National Association of Collier Managers. G. H. Winstanley. 12500 w. Ir & Coal Trds Rev—Sept. 25, 1908. No. 95636 A.

South Staffordshire Method of Mining Coal. Lucius W. Mayer. Description of typical operations in working a thick coal seam in this district. Ills. 3000 w. Eng & Min Jour—Oct. 3, 1908. No. 95793.

Mining Methods at Seaton-Delaval Colliery. Lucius W. Mayer. A thick coal seam with strong cover is mined by the longwall system. Ills. 3000 w. Eng & Min Jour—Oct. 17, 1908. No. 95954.

Operating a Nova Scotia Coal Mine. H. E. Coll. Illustrated description of mines and methods. 2500 w. Eng & Min Jour—Sept. 26, 1908. No. 95447.

We supply copies of these articles. See page 579.

Rescue Appliances.

The Anaconda Protective Hood. Robert N. Bell. Illustrated account of a home-made helmet for fighting underground fires and poisonous gases. Ills. 900 w. Eng & Min Jour—Oct. 10, 1908. No. 95760.

A Rescue Training School and Experimental Gallery for Miners. Description of the new Rescue Training School at Howe Bridge, near Atherton, Lancaster, with illustrations of appliances. 1000 w. Sci Am—Oct. 17, 1908. No. 95894.

Rescue Organization in the Ostrau-Karwin District and the Appliances at the Witkowitz Anthracite Mines at Mähr.-Ostrau (Ueber die Ausgestaltung des Rettungswesen im Ostrau-Karwiner Reviere im allgemeinen und insbesondere über die diesbezüglichen Einrichtungen bei den Witkowitzer Steinkohlengruben in Mähr.-Ostrau). August Fillunger. Ills. Serial. 1st part. 2800 w. Oest Zeitschr f Berg- u Hüttenwesen—Sept. 19, 1908. No. 96145 D.

Ventilation.

Hygrometric Observations in Coal Mines. A. H. Stokes. Description of experiments showing the value of hygrometric observations in connection with ventilation records. 3000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95860 A.

Washing.

Coal Washing at the State Mine Wilhelmina (Kolenzeverij en -wasscherij der Staatsmijn Wilhelmina). L. Davidson. Illustrated description of the plant and methods at this mine in Holland. 3800 w. De Ingenieur—Sept. 19, 1908. No. 96245 D.

COPPER.

Assaying.

Laboratory Routine in Modern Copper Smelters. H. T. Waller. Description of laboratory methods useful in connection with copper blast furnace smelting. 6000 w. Inst of Min & Met, Bul. 49—Oct. 8, 1908. No. 96090 N.

Atacamite Ores.

The Commercial Extraction of Copper from Atacamite Ore. A. J. Evans. Describes deposits in Chile, and gives a résumé of methods tried for treatment. 1500 w. Min Jour—Oct. 10, 1908. No. 95990 A.

British Columbia.

Handling Three Thousand Tons of Ore per Day at the Granby Mines and Smelter, Phoenix and Grand Forks, B. C. A. B. W. Hodges. Illustrated description of the machinery and methods. 2000 w. Jour Can Min Inst—1908. No. 96247 N.

Chili.

See Atacamite Ores, under COPPER.

Converters.

Operation of an Anaconda Copper Converter. C. Offerhaus. Explains reactions of the process, details of lining, charging, blowing, pouring and changing the vessels, etc. Ills. 5500 w. Eng & Min Jour—Oct. 17, 1908. No. 95949.

Electro-Metallurgy.

Five-Ton Electrolytic Copper Refining Plant. Chas. C. Christensen. Discussion of consumption of electricity in depositing copper and methods. 1000 w. Min Wld—Oct. 3, 1908. No. 95655.

Idaho.

The Ore Deposits at Mineral, Idaho. H. W. Turner. Discusses nature and occurrence of silver and copper ore deposits and geological functions. Ills. 4000 w. Ec Geol—Aug.-Sept., 1908. No. 95707 D.

Lake Superior.

Lode Copper Mining on Keweenaw Point, Mich. Charles J. Stone. Describes the deposits and their development. 1200 w. Min Wld—Oct. 17, 1908. No. 95928.

Mexico.

Nacozari Mining District, Sonora, Mexico. B. E. Russell. Description of a region which once yielded gold, silver, and lead, but now promises to become a most important copper camp. Ills. 4000 w. Eng & Min Jour—Oct. 3, 1908. No. 95788.

The Moctezuma Copper Deposits in Mexico. Charles A. Dinsmore. History and geology of the Pilares mine, at Nacozari, Sonora, Mexico. Cost and methods of mining. Ills. 3000 w. Min Wld—Sept. 26, 1908. No. 95449.

Smelters.

Smelting Works at Rio Blanco, Peru Description of a first-class smelting plant recently completed by the Peruvian Mining, Smelting & Refining Co. Ills. 1000 w. Min & Sci Pr—Oct. 3, 1908. No. 95824.

Smelting.

See Assaying, and British Columbia, under COPPER.

United States.

Notes on Copper Mining in the American Colonies. Edgar T. Wherry. Historical account of the opening of early copper mines. 2400 w. Jour Fr Inst—Oct., 1908. No. 95695 D.

Utah.

The Boston Consolidated Mine. An illustrated account of an interesting low-grade copper property. 4500 w. Min Jour—Oct. 3, 1908. No. 95902 A.

GOLD AND SILVER.

Assaying.

Methods of Making Crucible Assay Calculations. Robert B. Brinsmade. A summary of crucible assaying of gold-silver ores devised for the use of students. 2500 w. Min Wld—Oct. 3, 1908. No. 95653.

Australia.

The Gold Fields of West Australia. Arthur Selwyn-Brown. An illustrated article reviewing the development, geological features and production. 3000 w. Engineering Magazine—Nov., 1908. No. 96203 B.

Deep Lead Mining in Australia. D. H.

Browne. An account of the gold mining industry and the working of the mines. Ills. 4500 w. Min & Sci Pr—Oct. 24, 1908. No. 96232.

See also same title, under LEAD AND ZINC.

Bromo-Cyaniding.

See Diehl Process, under GOLD AND SILVER.

California.

Unexplored Part of Oregon-California Divide. Dennis H. Stovall. Information concerning a district rich in gold and copper and mine timber. Ills. 1200 w. Min Wld—Oct. 24, 1908. No. 96044.

Cobalt.

The Geology of Cobalt. Abstract of a report of the Bureau of Mines of Ontario prepared by W. G. Miller, which discusses the cobalt-nickel arsenides and silver deposits of Temiskaming. 1800 w. Eng & Min Jour—Oct. 10, 1908. No. 95761.

Cobalt Profits Which Make Time Precious. Alex. Gray. A brief review of mining properties and their output. 3000 w. Min Jour—Oct. 17, 1908. No. 96051 A.

See also Ore Deposits, under MISCELLANY.

Colombia.

Mining in Narino; Republic of Colombia. Henry Edwards. A report of mining properties, particularly of gold deposits, though copper, silver, tin, platinum, and coal have been discovered. 2000 w. Min Jour—Oct. 17, 1908. No. 96052 A.

Quartz Mines in Colombia, South America. F. F. Sharpless. Illustrated description of quartz mining and the principal mines. Opportunities for vein mining as well as for placers. 1500 w. Min & Sci Pr—Sept. 26, 1908. No. 95571.

The Future Gold Output of Colombia. Henry G. Granger. Remarks on the present conditions in Colombia, its resources, especially the gold ores. 4000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95465 C.

See also Dredging, under GOLD AND SILVER.

Cyaniding.

Cyaniding Gold Ores. Clyde H. Jay. Gives information that will enable the inexperienced chemist to make all tests. 3000 w. Aust Min Stand—Sept. 9 and 16, 1908. Serial. 2 parts. No. 96225 each B.

Notes on Cyanide Treatment of Gold Ores. G. E. Bray. Gives details of the scope and cost of the cyanide treatment. 5000 w. Queens Gov Min Jour—Sept. 15, 1908. No. 96224 B.

Agitation by Compressed Air. F. C. Brown. Illustrated description of use of agitation in tall tanks as practised in New Zealand. 2200 w. Min & Sci Pr—Sept. 26, 1908. No. 95572.

Silver Cyaniding in Mexico. J. B. Emp-son. Discusses the application of the cyanide process to low grade ores. 1600 w. Eng & Min Jour—Oct. 3, 1908. No. 95791.

Cyanidation of Silver Ores, Pochuca, Mexico. Claude T. Rice. Description of large mills where the ore is completely slimed and where air agitation is used the ore is roughly concentrated. Ills. 5000 w. Eng & Min Jour—Oct. 3, 1908. No. 95786.

The Cyaniding of Silver Ores in Mexico (Le Traitement des Minerais d'Argent par la Cyanuration, au Mexique). Albert Bordeaux. A general review of the whole process. Ills. 5600 w. Génie Civil—Sept. 12, 1908. No. 96125 D.

Jesus Maria and Flores Mills, Guanajuato. Claude T. Rice. Illustrated description of two mills of this district where by cyaniding the silicious gold-silver ores an average extraction of 86% silver and 88% gold has been obtained. 3500 w. Eng & Min Jour—Sept. 26, 1908. No. 95445.

Recent Cyanide Practice in Korea. A. E. Drucker. Describes the candlestick plant of the Oriental Consolidated Mining Co. of northwestern Korea. Ills. 3000 w. Min & Sci Pr—Oct. 3, 1908. No. 95823.

The Estimation of Sulpho and Ferrocyanides, etc., in Cyanide Solutions Containing Copper. Leonard M. Green. Describes reactions, and gives a series of tests dependent on many of them by which the estimations may be made. 3000 w. Inst of Min & Met, Bul. 49—Oct. 8, 1908. No. 96092 N.

See also Malay States, under GOLD AND SILVER.

Diehl Process.

Bromo-Cyaniding of Gold Ores. E. W. Nardin. Description of the Diehl process as carried on at the Hannan's Star plant. 2500 w. Min & Sci Pr—Oct. 24, 1908. No. 96231.

Dredging.

Gold-Dredging on the Choco River, Republic of Colombia, South America. Henry G. Granger. A descriptive record of an important gold-dredging field. Maps. 10500 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95476 D.

Gold Refining.

Electrolytic Gold Refining. Emil Wohlwill. Gives objections to calculations made by Dr. J. W. Richards. 3000 w. Elec-Chem & Met Ind—Nov., 1908. No. 96095 C.

Hydraulic Mining.

La Grange Hydraulic Mine. Donald F. Campbell. Illustrated detailed account of the profitable mining of low-grade auriferous gravel, in northern California. 1800 w. Min & Sci Pr—Oct. 10, 1908. No 95916.

Idaho.

See same title, under COPPER.

Malay States.

Mining and Milling Practice at the

Raub Mine, Pahang. H. F. Lofts. Describes a gold mine, possibly the oldest in the Malay States, and the cyanide practice. 1800 w. Min Jour—Oct. 10, 1908. No. 95989 A.

Mexico.

Present Condition of Mining in Mexico. Franklin W. Smith. Discusses financial and commercial conditions and attempts at a lower cost of production. 1700 w. Eng & Min Jour—Oct. 3, 1908. No. 95787.

Mining in Mexico, Past and Present. E. A. H. Tays. Describes early methods of mining and reduction and discusses the Mexican miner. Ills. 2400 w. Eng & Min Jour—Oct. 3, 1908. No. 95790.

The Silver Mines of Mexico. Albert F. J. Bordeaux. A survey of the present condition of these mines. 4000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95464 C.

Hacienda Buburon, an Old Mexican Silver Mill. Mark R. Lamb. Description of primitive crushing and grinding appliances in the Guanajuato District. Ills. 1200 w. Eng & Min Jour—Oct. 3, 1908. No. 95789.

Guanajuato, the Great Silver Camp of Mexico. Claude T. Rice. Describes the mines of the district, its history, geology and present conditions and operation. Ills. 2500 w. Eng & Min Jour—Oct. 3, 1908. No. 95792.

The Working Mines of Guanajuato. Claude T. Rice. An illustrated account of the principal mines of the district. 1500 w. Eng & Min Jour—Oct. 24, 1908. No. 96031.

Rejuvenation of Guanajuato Camp, Mexico. Thos. C. Welch. Description of ancient and modern methods used in this famous district with particular reference to recent activity. 4000 w. Min Wld—Oct. 3, 1908. No. 95654.

See also Cyaniding, under GOLD AND SILVER; and Mexico, under COPPER.

Nevada.

Decline and Revival of Comstock Mining. Whitman Symmes. A critical discussion of the methods of exploiting this property. Ills. 3500 w. Min & Sci Pr—Oct. 10, 1908. Serial. 1st part. No. 95918.

Present Conditions in Goldfield District, Nevada. G. E. Walcott. Describes leasing system and company work, operation of the various properties and output of the district. Ills. 1300 w. Eng & Min Jour—Oct. 10, 1908. No. 95766.

Placers.

Saving Minerals from Beach Sands. Account of a novel device for recovering minerals from the beach sands of Richmond River, New South Wales. Abstracted from the *Town and Country Journal*. Ills. 900 w. Min Wld—Oct. 10, 1908. No. 95769.

Rand.

The Chinese on the Rand. T. Lane Carter. A brief account of labor-conditions in the Transvaal, describing the experience with the Chinese and the work they have accomplished. 7500 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95466 C.

See also Gold Milling, and Sampling, under ORE DRESSING AND CONCENTRATION.

IRON AND STEEL.

Blast-Furnace Charging.

Recent Blast-Furnace Charging Inclines (Neuere Hochofen-Schrägaufzüge). Ignaz Sturm. Illustrated description of a new type of automatic charging installation built by J. Pohlig, Cologne. 1600 w. Oest Zeitschr f Berg- u Hüttenwesen—Sept. 26, 1908. No. 96146 D.

Blast-Furnace Fuels.

The Use of Charcoal in Blast Furnace Practice. Describes kilns for charcoal and by-products employed in Sweden, and discusses the charcoal iron industry. Ills. 3500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95862 A.

Blast-Furnace Gas.

See England, under IRON AND STEEL.

Blast-Furnace Practice.

The Relation of Slow Driving to Fuel Economy in Iron Blast-Furnace Practice. John B. Miles. Gives data of blast-furnace records with deductions. 1500 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95470 C.

An Unusual Blast-Furnace Product; and Nickel in Some Virginia Iron-Ores. Frank Firmstone. Describes the material and the occurrence. 600 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95472 C.

Fuel Consumption in Blast Furnaces (Ueber den Brennstoffverbrauch beim Hochofenbetriebe). Carl Brisker. Works out the heat balance and shows the possibility of greater economy. 3600 w. Stahl u Eisen—Sept. 9, 1908. No. 96139 D.

See also Iron Ores, under ORE DRESSING AND CONCENTRATION.

Blast Furnaces.

A Description of Messrs. Bell Brothers' Blast-Furnaces from 1844-1908. Greville Jones. A paper read before the Iron & Steel Institute. Ills. 4000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95847 A.

California.

The Occurrence and Genesis of the Magnetite Ores of Shasta Co., Cal. Basil Prescott. Discusses the formation of these minerals. Ills. 4000 w. Ec Geol—Aug.-Sept., 1908. No. 95705 D.

China.

Iron, Steel and Fuel in China. W. D. B. Dodson. An account of the first iron mine and reduction plant in China. 1500 w. Min & Sci Pr—Oct. 10, 1908. No. 95917.

Dry-Air Blast.

A Gayley Dry Blast Installation. Illustrates and describes the refrigerating

plant of the dry blast equipment of the Illinois Steel Company's South Works, which contains four refrigerating machines of 300 tons capacity each. Ills. 2200 w. Ir Age—Oct. 8, 1908. No. 95878.

Electro-Metallurgy.

The Development of the Lash Process for Making Soft Steel in the Electric Furnace. A brief illustrated description of the process and the results obtained. 1800 w. Can Min Jour—Oct. 15, 1908. No. 95912.

The Production of Finished Iron Sheets and Tubes in One Operation. Sherard Cowper-Coles. A paper read before the I. and S. Institute which describes the electrolytic production in finished form of iron plates and tubes. Ills. 3500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95854 A.

The Stassano Electric Furnace. Abstract of a paper by M. Stassano in the *Revue de Métallurgie* describing the furnace and the results obtained at Turin where two plants are now operated. Ills. 2500 w. Ir Age—Oct. 8, 1908. No. 95877.

The Electro-Metallurgy of Iron (Sur la Métallurgie Thermo-Electrique du Fer). M. Stassano. Describes the author's furnace, the installations at Turin, and the results obtained. Ills. 9000 w. Rev de Métal—Sept., 1908. No. 96106 E + F.

Recent Advances in Electric Iron and Steel Production (Neueres über die elektrische Eisen- und Stahlerzeugung). Franz Peters. A general review of progress in Europe and America. Ills. 2500 w. Glückauf—Sept. 26, 1908. No. 96151 D.

Progress on the Electric Iron and Steel and Ferro Alloy Industries. John B. C. Kershaw. First part of a series of articles describing the condition of the electric iron and steel industry of the world. 1700 w. Id Trd Rev—Oct. 1, 1908. No. 95584.

See also Foundry Furnaces, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

England.

The Iron & Steel Industries of the Cleveland District During the Last Quarter of a Century. W. Hawdon. A paper read before the Iron & Steel Institute. Ills. 3300 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95851 A.

Power Supply and Its Effect on the Industries of the Northeast Coast. Charles H. Merz. A paper read before the Iron & Steel Institute which discusses the provision of electricity for industrial use. Ills. 5500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95853 A.

France.

The Iron Ore Fields of the French Lorraine. An illustrated account of the deposits and their development. 1500 w. Ir & Coal Trds Rev—Sept. 18, 1908. No. 95437 A.

Germany.

The Ilsede Hütte Iron-Mines at Peine, Germany. Lucius W. Mayer. Describes mines and methods. Ills. 1600 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95471 C.

Lake Superior.

See Iron Ore, under ORE DRESSING AND CONCENTRATION.

Metal Mixers.

The Future Development of the Metal-Mixer and the Open-Hearth Process. Arthur E. Pratt. A paper read before the British Iron & Steel Institute which outlines the possibility of extending the use of the metal-mixer and suggests a new steel-making process. 14000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95863 A.

Nevada.

Amarilla Iron and Phosphate Deposits. Oscar H. Hershey. Describes these deposits in Nevada. 1500 w. Min & Sci Pr—Oct. 17, 1908. No. 96022.

Open Hearth.

The Chemical Control of the Basic Open-Hearth Process. Alfred Harrison and Richard Vernon Wheeler. A paper presented to the Iron & Steel Institute which describes a scheme for the complete following of the various reactions. Ills. 3500 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95855 A.

See also Metal Mixers, and Steel Works, under IRON AND STEEL.

Pig Iron.

Analyses of British Pig Irons Shown at the Franco-British Exhibition. 6400 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95857 A.

Rolling Mills.

Electrical Mill Equipment. Illustrated description of new rolling and cogging mills electrically driven at Dorman, Long & Co.'s Works, Middlesborough. 2200 w. Engr, Lond—Sept. 25, 1908. No. 95670 A.

Some Results of Experience with Electrically-Driven Rolling Mills. C. Koettgen and C. A. Ablett. Read before the I. and S. Inst. Discusses the advantages of electric driving. Ills. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95846 A.

Sheets.

See Electro-Metallurgy, under IRON AND STEEL.

Steel Making.

See Metal Mixers, under IRON AND STEEL.

Steel Works.

Messrs. Bolckow, Vaughan & Co.'s Cleveland Iron and Steel Works. Description of a large British plant. Ills. 3000 w. Engng—Oct. 2, 1908. No. 95710 A.

Britannia Works. Description of the basic open-hearth plant of Messrs. Dorman, Long & Co., at Middlesbrough. Ills. 2000 w. Engng—Sept. 25, 1908. No. 95641 A.

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The Clarence Iron and Steel Works, Port Clarence. Describes features of a large plant on Durham side of the Tees. 1400 w. Engng—Sept. 25, 1908. No. 95642 A.

Open-Hearth Steel Works of the French Admiralty at Guerigny. Illustrated description of the plant. 1400 w. Ir & Coal Trds Rev—Sept. 25, 1908. No. 95635 A.

The New Plant of the Cargo Fleet Iron Company, Middlesbrough (Die neuen Werksanlagen der Cargo Fleet Iron Company in Middlesbrough). Emil Jagsch. Illustrated detailed description of the works of this large company. 6500 w. Stahl u Eisen—Sept. 16, 1908. No. 96141 D.

The Frederic-Albert Works at Rheinhausen (L'Usine Frederic-Albert, à Rheinhausen). Illustrated description of this large Krupp plant. Abstract translation from *Stahl und Eisen* for Oct. 9, 1907. 7500 w. Rev de Métal—Sept., 1908. No. 96107 E + F.

The Jubilee of the Jlsede Steel Works (Zum 50 jährigen Jubiläum der Jlseder Hütte). A historical sketch and illustrated description of the present plant near Peine, Germany. 5000 w. Stahl u Eisen—Sept. 16, 1908. No. 96140 D.

Sweden.

The Routivars and Vallatj Iron Ore Deposits (Die Eisenerzvorkommen des Routivara und des Vallatj). Dr. Hecker. Illustrated description of these deposits in northern Sweden. 2500 w. Glückauf—Sept. 19, 1908. No. 96150 D.

LEAD AND ZINC.

Australia.

The Silver-Lead-Zinc Mines at Broken Hill. G. W. Williams. Illustrates and describes the ores, mines and methods. 4000 w. Eng & Min Jour—Oct. 24, 1908. No. 96029.

Lead Smelting.

Erection and Equipment of the Tintic Smelter. Leroy S. Palmer. Illustrated description. Electricity for power and light. 1800 w. Min Wld—Sept. 26, 1908. No. 95448.

Removing Accretions in Crucible of Lead-Furnaces. J. N. Goddard. Information concerning the bomb designed by J. O. Bardell. 700 w. Eng & Min Jour—Oct. 17, 1908. No. 95953.

Bag House of United States Smelter in Utah. Holland E. Benedict. Illustrated description of the construction and arrangement of bag house for filtering the dust laden fumes from the smelter. 1500 w. Min Wld—Oct. 24, 1908. No. 96043.

Missouri.

Power Plant of Joplin Mills. Doss Brittain. Description of various plants in this district. 1000 w. Min Wld—Oct. 3, 1908. No. 95652.

Lead and Zinc Ores in Missouri. J. R. Finlay. Describes the general character of the ores, and the methods and costs of mining. 6500 w. Eng & Min Jour—Sept. 20, 1908. No. 95443.

Zinc Smelting.

A Rotatable Zinc Furnace. George A. Wettenzel. Illustrated description of a furnace which does away with the processes of hand charging and blowing out. 500 w. Elec-Chem & Met Ind—Nov., 1908. No. 96098 C.

MINOR MINERALS.

Cement.

Review of the Cement Industry for 1907. Robert W. Lesley. Review prepared for *The Mineral* Industry for 1907. 8000 w. Cement Age—Oct., 1908. No. 96078 C.

The Mechanical Side of the Cement Industry. A series of short articles describing all the stages through which the material must pass, and the appliances used. Ills. 16000 w. Cement Age—Oct, 1908. No. 96079 C.

Cement Materials of Western Virginia. R. S. Bassler. Describes distribution of cement materials and natural cement and the cement industry in Virginia. Ills. 6500 w. Ec Geol—Aug.-Sept., 1908. No. 95708 D.

Graphite.

The Graphite Mines of Santa Maria. J. C. Mills. Describes occurrence of graphite in Sonora, Mexico, methods of mining and treatment. 1100 w. Mines & Min—Oct., 1908. No. 95624 C.

Mercury.

Mercury Mines at Koniah, Asia Minor. Frederick F. Sharpless. Illustrated description of ancient workings idle for probably 3000 years, now being opened for operation. 500 w. Eng & Min Jour—Sept. 26, 1908. No. 95442.

Oil.

Geology of Illinois Petroleum Fields. H. Foster Bain. Describes occurrence of gas and petroleum and indicates the possibility of additional supplies. Map and Ills. 3500 w. Ec Geol—Aug.-Sept., 1908. No. 95706 D.

Phosphate.

Modern Land-Pebble Phosphate-Mining Plants in Florida. H. D. Mendenhall. Illustrates and describes the mining methods, the occurrence, and details of the plant. 6000 w. Eng News—Oct. 15, 1908. No. 95957.

See also Nevada, under IRON AND STEEL.

Platinum.

Dredging for Platinum in the Urals, Russia. L. Tovey. Describes the exhaustion of the richer deposits and dredging methods for the gravels too poor to be worked by hand. Ills. 3300 w. Eng & Min Jour—Oct. 10, 1908. No. 95758.

Salt.

Salt Manufacture. George E. Willcox

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Describes recent developments in the mechanical methods and appliances of large salt plants. Ills. 3500 w. Jour Am Soc of Mech Engrs.—Oct., 1908. No. 96042 F.

Sand.

The Cape May Sand Company's Plant. Illustrated description of the plant and processes. 1500 w. Ir Age—Oct. 22, 1908. No. 96001.

Sapphires.

Development of Montana Sapphire Industry. Douglas B. Sterrett. Describes the geology and operation of mines. 4000 w. Min Wld—Sept. 26, 1908. No. 95451.

Talc.

Talc and Soapstone in Vermont. G. H. Perkins. Describes the occurrence, quarrying, etc. 1200 w. Eng & Min Jour—Oct. 17, 1908. No. 95950.

Tin.

The World's Tin Supply. T. Good. Discusses present and future supplies. 2000 w. Cassier's Mag—Oct., 1908. No. 95658 B.

Quantitative Separation of Tin from Manganese, Iron and Chromium by Electrolysis. W. T. Williams. Translation of a paper by M. N. Puschin in the *Journal de la Société Physico-Chemique Russe.* 4000 w. Jour Fr Inst—Oct., 1908. No. 95694 D.

MINING.

Accidents.

Mining Accidents in 1907. Extract from Part II of the General Report and Statistics relating to Mines and Quarries in 1907, dealing with accidents in the United Kingdom. Also editorial. 3500 w. Col Guard—Sept. 25, 1908. No. 95864 A.

Caving System.

Surface Effects of the Caving System. Lucien Eaton. Discussion of this system of mining with results of caving in a mine on the Gogebic range. 1300 w. Min & Sci Pr—Sept. 26, 1908. No. 95573.

Drills.

Air-Drills and Their Efficiency. Sam'l K. Patterson. General discussion. 1800 w. Min & Sci Pr—Oct. 3, 1908. No. 95825.

Economics.

The Economy of Winning Ore. W. H. Doherty. Discusses how to increase the efficiency in the getting and transporting of ore from face to mill. Ills. 3500 w. Queens Gov Min Jour—Aug. 15, 1908. No. 95434 B.

Electric Hoisting.

Electric Hoisting Plant at the Hausham Mine of the Upper Bavaria Coal Mining Company at Miesbach (Die elektrisch betriebene Hauptschachtförderanlage auf Grube Hausham der Oberbayerischen Aktiengesellschaft für Kohlenbergbau in Miesbach). Herr Janzen. Illustrated detailed description. 2000 w. Elek Kraft u Bahnen—Sept. 14, 1908. No. 96186 D.

Electric Power.

The Use of Electricity in Mines. Geo. R. Wood. Brief discussion of the problems involved with typical examples. Ills. 1650 w. Ind Wld—Oct. 12, 1908. No. 95889.

Electric Power for Quarrying Marble. C. T. Maynard. An illustrated description of the electric system of the Vermont Marble Co. 2500 w. Power—Oct. 13, 1908. No. 95839.

See also Haulage, under MINING.

Engineering Ethics.

Professional Ethics for the Mining Engineer. John Hays Hammond. An address before the American Institute of Mining Engineers. 3400 w. Eng & Min Jour—Oct. 10, 1908. No. 95763.

Haulage.

Underground Transport of Material. J. Bowie Wilson. Suggestions for mine haulage. 2200 w. Aust Min Stand—Sept. 16, 1908. No. 96227 B.

Electricity in Mines. Illustrates and describes a large main-and-tail haulage gear at Gateshead-on-Tyne, and other electrical plant. 1000 w. Col Guard—Oct. 16, 1908. No. 96053 A.

Rope Haulage at the Carl Mine near Diedenhofen (Die Seilförderung im Carlstolln bei Diedenhofen). Herr Schartzkopff. Describes the plant and haulage arrangements for this iron mine and gives the operating cost. Ills. 2500 w. Stahl u Eisen—Sept. 23, 1908. No. 96143 D.

Head Frames.

Graphical Head-Frame Design (Calcul Graphique d'un Châssis à Molettes). H. Keckstein. Translated from *Kohle und Erz.* Works out a complete practical example. Ills. 3500 w. All Indus—Sept., 1908. No. 96119 D.

Keps.

The Arrangement of Keps for Modern Collieries. J. S. Barnes. Drawings and descriptons of old and new systems. 2500 w. Ir & Coal Trds Rev—Oct. 16, 1908. No. 96064 A.

Mine Telephones.

The Mine Telephone and Its Advantages. Discusses the construction and use of mine telephones. Ills. 1500 w. Eng & Min Jour—Oct. 10, 1908. No. 95765.

Ore Chutes.

The Finger Chute. T. A. Rickard. Illustrated description of a device for expediting the descent of ore into cars. 1200 w. Min & Sci Pr—Oct. 17, 1908. No. 96023.

Prospecting.

River Prospecting for Gold. Marshall Macfarlane. Describes an effective plant and methods of work in French Guinea. Ills. 1600 w. Min Jour—Sept. 19, 1908. No. 95424 A.

Quarrying.

See Electric Power, under MINING.

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Shaft Accidents.

The Alpha Shaft Disaster. W. S. Larsh. Describes methods for securing shaft and rescuing entombed miners with plans and diagrams. 2000 w. Mines & Min—Oct., 1908. No. 95626 C.

Surveying.

Surveying at Lytle Colliery. John H. Haertter. Description of an accurate survey of a mine near Minersville, Pa. Ills. 3000 w. Mines & Min—Oct., 1908. No. 95627 C.

Timbering.

Lining-Up Timbers in Inclined Shafts. Benjamin H. Case. Illustrates and describes methods used at Ducktown, Tenn. 1600 w. Eng & Min Jour—Sept. 26, 1908. No. 95444.

Timber Preservation.

Prolonging Life of Mine Timber. John M. Nelson, Jr. Describes experiments with different preservatives and by open- and closed-tank processes, with summary of results. Ills. 5500 w. Mines & Min—Oct., 1908. No. 95631 C.

Tunnelling.

The Karns Tunneling Machine. R. L. Herrick. Illustrated description of the test of a machine designed to drive a tunnel by cutting the rock and without the use of explosives. 1700 w. Mines & Min—Oct., 1908. No. 95628 C.

Advancing the Hot Time Lateral of the Newhouse Tunnel. Henry M. Adkinson. Describes methods used in the rapid driving of a cross-cut 5 x 7½ ft. in size. Also editorial. 4500 w. Eng & Min Jour—Oct. 17, 1908. No. 95951.

Ventilation.

The Ventilation of Mines. Johan Sarvaas. The present number discusses the causes of the vitiation of the air in mines. 2200 w. Aust Min Stand—Sept. 9, 1908. Serial. 1st part. No. 96226 B.

ORE DRESSING AND CONCENTRATION.

Classifiers.

See Jigs, under ORE DRESSING AND CONCENTRATION.

Concentration.

Slipping and Falling of Granular Materials in Water (Glissement et Eboulement des Matériaux en Grains, leur Entrainement par l'Eau). A. Barbonneau. A theoretical mathematical discussion, deducing formulæ and giving constants obtained by experiment. Ills. Serial. 1st part. 4800 w. Génie Civil—Sept. 19, 1908. No. 96126 D.

Filtration.

Continuous Vacuum-Filter Machine. Bertram Hunt. Illustrated description of a continuous filter for slime cyaniding designed by the author. 1300 w. Min & Sci Pr—Sept. 26, 1908. No. 95574.

An Improved Press for Filtering Cyanide Slimes. Ernest J. Sweetland. Description of a new press designed to handle slimes from the cyanide process efficiently and economically. Ills. 1000 w. Eng & Min Jour—Oct. 10, 1908. No. 95768.

Gold Milling.

Rusty Gold, and How It Is Saved. Dennis H. Stovall. Method of saving dark red or "rusty" gold in placer mining. 1000 w. Min Wld—Oct. 3, 1908. No. 95656.

The New Esperanza Mill at El Oro, Mexico. Claude T. Rice. Illustrated description of the remodeled mill and plant to be erected for cyaniding tailings. 1800 w. Eng & Min Jour—Oct. 17, 1908. No. 95952.

An Electrically Driven 300-Stamp Mill on the Rand. Ralph Stokes. Description of a heavy stamp mill with a monthly capacity of 75,000 tons. 3200 w. Min Wld—Oct. 3, 1908. No. 95651.

Some of the Large Stamp Mills of the World. Chas. C. Christensen. Present part describes the Alaska Treadwell and Alaska Mexican Mills. Ills. Serial. 1st part. 1500 w. Eng & Min Jour—Oct. 10, 1908. No. 95767.

Iron Ores.

Concentration of the Mesabi Ore. H. H. Stoek. Describes an experimental concentrating plant of the Oliver Iron Mining Co. designed to treat poorer ores. Ills. 1000 w. Mines & Min—Oct., 1908. No. 95623 C.

The Mechanical Cleaning of Iron Ores. T. C. Hutchinson. A paper presented to the Iron & Steel Institute which states the great advantages and economy of removing impurities mechanically before the ore is charged into the blast furnace. 5000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95845 A.

Jigging.

The Separation of Metallic Ores by Jigging. Arthur Taylor. Describes a modification in the form of apparatus used and the substitution of a vibrator for the plunger, explaining the advantages. Ills. 4000 w. Inst of Min & Met, Bul. 49—Oct. 8, 1908. No. 96089 N.

Investigation on Jigging. Royal Preston Jarvis. Reviews previous investigations, giving a résumé of results; describes tests made with the Jarvis laboratory-jigs, with résumé and conclusions. Ills. 22800 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95469 D.

Jigs.

The Richards Pulsator Jig and Pulsator Classifier. R. L. Herrick. Describes two machines for hydraulic classification of ores. Ills. 2500 w. Mines & Min—Oct., 1908. No. 95630 C.

Mixing Machinery.

Mixing Machinery. Oskar Nagel. Illustrates and describes types. 1500 w. Elec-Chem & Met Ind—Oct., 1908. No. 95458 C.

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Roasting.

Roasting Furnaces. Oskar Nagel. Illustrates and describes types. 1500 w. Elec-Chem & Met Ind—Nov., 1908. No. 96097 C.

Sampling.

Rand Sampling Practice. J. S. Olver. Read before the Inst. of Mine Surveyors (Transvaal). Describes conditions and methods. 1700 w. Min Jour—Sept. 19, 1908. Serial. 1st part. No. 95425 A.

Stamp Mills.

Reinforced Concrete Foundations for Stamp Batteries. S. J. Truscott, and John P. Fuller. Illustrated description of work in Sumatra, where use was made of material at hand. 2500 w. Inst of Min & Met, Bul 49—Oct. 8, 1908. No. 96091 N.

Wilfley Table.

The Wilfley Table. Robert H. Richards. Gives results of tests made of a Wilfley table with a mixture of quartz and chalcopyrite. 2000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95468 C.

MISCELLANY.

Great Britain.

Twenty-five Years of Mining. Edward Ashmead. A retrospective review, 1880-1904, of mining companies registered in Great Britain, with notes and comments. 4500 w. Min Jour—Sept. 19, 1908. Serial. 1st part. No. 95426 A.

Ore Deposits.

The Relation of Magmatic Waters to Volcanic Action. Hiram W. Hixon. Discusses the great influence of magmatic waters. Ills. 4000 w. Jour Fr Inst—Oct., 1908. No. 95725 D.

Origin of Cobalt-Silver Ores of Northern Ontario. R. E. Hore. Gives results of a study of these ores in field and laboratory. 3300 w. Jour Can Min Inst—1908. No. 96246 N.

A New Theory of the Genesis of Brown Hematite-Ores; and a New Source of Sulphur Supply. H. M. Chance. Aims to show that the accepted hypothesis explaining the genesis of these ores is untenable, presenting reasons to show that the ores are derived from oxidation of pyrite and pyritic material *in situ*. 7000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95474 C.

Petrography.

The Distribution of the Elements in Igneous Rocks. Henry S. Washington. A study of the composition, petrographic provinces of the United States and elsewhere, and facts as yet imperfectly understood. 12000 w. Bul Am Inst of Min Engrs—Sept., 1908. No. 95475 D.

Philippines.

Metallic Mineral Resources of the Philippines. Maurice Goodman. Abstract from *The Mineral Resources of the Philippine Islands*, issued by the Bureau of Science. Manila, 1908. 2000 w. Eng & Min Jour—Oct. 10, 1908. No. 95759.

Portugal.

The Structure or Tectonic Geology of the Arrabida Chain of Mountains, Portugal. Paul Choffat. Descriptive. 2000 w. Min Jour—Sept. 19, 1908. No. 95422 A.

Refractory Materials.

Use of Basic Refractory Brick in Metallurgy. Francis T. Havard. Considers the sources and cost of magnesite and chromite and the advantages and disadvantages of employing these minerals for furnace linings. 2500 w. Eng & Min Jour—Oct. 24, 1908. No. 96030.

Siberia.

Siberian Mining: Hints to Foreigners. Notes on knowledge essential to foreigners visiting the country and the conditions of mining in Eastern Siberia, laws, taxes, etc. Siberia produces annually some 6 million pounds sterling of gold. 6500 w. Min Jour—Sept. 19, 1908. No. 95423 A.

Strikes.

Strikes and Lockouts in the Mining and Quarrying Industries in 1907. Extract of a report by A. Wilson Fox of the Labor Department of the British Board of Trade. Also editorial. 2500 w. Col Guard—Oct. 2, 1908. No. 95867 A.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Publicity for Accidents on the Harriman Lines. Description of method employed to investigate accidents and the issuing of bulletins to the press and public. 3000 w. R R Age Gaz—Oct. 2, 1908. No. 95561.

Dispatching.

Train Despatching by Telephone. G. W. Dailey. Detailed description of the successful use of the telephone in train despatching on the Chicago and Northwestern. 3400 w. R R Age Gaz—Oct. 9, 1908. No. 95755.

Dispatching Trains by Telephone. W. W. Ryder. A paper read before the Association of Railway Telephone Superintendents. Discusses methods of despatching by telephone as used on the C. B. & Q. R. R. 2000 w. Sig Engr—July, 1908. No. 95814.

We supply copies of these articles. See page 579.

Signalling.

The Gardiner System of Cab Signalling. Diagrams and description. 2200 w. Elect'n, Lond—Oct. 16, 1908. No. 96047 A.

Signals.

A Talk on Torque. M. Wuerpel, Jr. Theoretical consideration of the forces involved in moving the spectacle and semaphore of a railway signal. Ills. 5000 w. Sig Engr—Oct., 1908. No. 95819.

The "Universal Auto-Combiner." Illustrated detailed description of a power-interlocking apparatus in experimental use in France. 2500 w. R R Age Gaz—Oct. 23, 1908. No. 96027.

All-Electric Interlocking at New Haven. Description of the system recently completed. Ills. 3000 w. R R Age Gaz—Oct. 9, 1908. No. 95756.

The Electro-Pneumatic Signal and Interlocking System at the New Union Station, Washington, D. C. Fred. W. Bender. Detailed description, with plans and diagrams. Ills. 3500 w. Sig Engr—Oct., 1908. No. 95822.

A Remarkable Block Signal System. A. D. Cloud. Describes the normal danger automatic block signal system recently installed on the Metropolitan West Side Elevated Railroad of Chicago. Ills. 1800 w. Sig Engr—Oct., 1908. No. 95821.

Electro-Pneumatic Interlocking on the D. L. & W. R. R. at Hoboken. H. A. Applegate. Detailed description of a large terminal plant with diagrams and plate. Ills. 2000 w. Sig Engr—Sept., 1908. No. 95818.

Electro-Pneumatic Interlocking Plants at the St. George Terminal of the Staten Island Rapid Transit Railroad. Fred. W. Bender. Illustrated description. 1300 w. Sig Engr—Sept., 1908. No. 95816.

Electro-Pneumatic Interlocking Plant on the Chicago and Western Indiana R. R. at 47th St., Chicago. Stanley C. Bryant. Account of the new signalling installation on recently elevated tracks in Chicago. Sig Engr—July, 1908. No. 95813.

Upper Quadrant Signals on the Great Northern Railway Line. Account of automatic and interlocking block signal systems between St. Paul and Minneapolis. Ills. and charts. 1300 w. Sig Engr—June, 1908. No. 95812.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Straight Air Brake Equipment. J. B. Parham. Considers their application to high-speed electric cars, illustrating and describing the motor air compressor. 3500 w. Can Soc of Civ Engrs—Oct. 22, 1908. No. 96073 N.

Cable Railways.

The Heidelberg Mountain Railway (Die Bergbahn Heidelberg). A. Schmidt. Illustrated description of a cable railway from the city to the castle on the mountain, the equipment driving engines, etc. 5500 w. Zeitschr d Ver Deutscher Ing—Sept. 19, 1908. No. 96194 D.

Car Lighting.

A New and Improved Method of Lighting Railway Carriages by Liquefied Oil Gas ("Blaugas"). F. D. Marshall. An illustrated description of the application of "Blaugas" to car lighting with consideration of its cost and illuminating power. 1800 w. Gas Wld—Oct. 3, 1908. No. 95868 A.

Cars.

Hopper Ballast Car for Burma Railways. Illustrated description. 500 w. R R Age Gaz—Oct. 16, 1908. No. 95963.

50-Ton Gondola for the Burlington. Illustrated description. 300 w. R R Age Gaz—Oct. 23, 1908. No. 96026.

Steel Car Construction and Maintenance. G. E. Carson. Describes construction, maintenance, repairs, painting, etc., with comparative cost of repairs of wood and steel cars. 4000 w. Am Engr & R R Jour—Oct., 1908. No. 95541 C.

Electrification.

The Electrification of the Victorian Railways. Abstract of a Report by C. H. Merz to the Victorian Railway Commissioners on the proposed project. Map and plans. 4000 w. Elec Engng, Lond—Sept. 24, 1908. No. 95638 A.

Electrification of the Melbourne Suburban Railways. Account of proposed change from steam to electricity with plans and diagrams showing proposed station and cars. Discusses engineers' report on a system which has 240 miles of track and plans involving an outlay of over $10,000,000. 4000 w. Elec Ry Jour—Oct. 3, 1908. No. 95593.

Proposed Electrification of the Illinois Central. Abstract of the principal portions of the report on Local Transportation at Chicago, which relate to the Illinois Central terminal. 3000 w. R R Age Gaz—Oct. 23, 1908. No. 96025.

Locomotive Boilers.

Washing and Filling Locomotive Boilers with Hot Water. Discusses some of the systems. 1700 w. R R Age Gaz—Oct. 16, 1908. No. 95962.

Care of Boilers at Terminals. J. F. Whiteford. Discusses increase of efficiency through proper handling at the roundhouse. 4000 w. Am Engr & R R Jour—Oct., 1908. No. 95535 C.

Locomotive Operation.

The Dynamics of Locomotive Machinery. Mathematical discussion of behavior of certain parts of locomotive machinery. 2500 w. Am Engr & R R Jour—Oct., 1908. No. 95537 C.

Locomotive Repairs.

Welding Locomotive Frames. A. W. McCaslin. Describes, with diagrams,

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method used on Pittsburgh & Lake Erie R. R. to repair frames without removing from engine. 800 w. Am Engr & R R Jour—Oct., 1908. No. 95536 C.

See also Welding, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Locomotives.

The Modern Locomotives of the Bengal-Nagpur Railway. Describes different types of locomotives used on this railway. Illus. 3300 w. Mech Eng—Oct. 2, 1908. No. 95704.

Modern British Practice in Tank Locomotives. Illustrates and describes representative types. 2500 w. Mech Wld—Oct. 9, 1908. Serial. 1st part. No. 95977 A.

Mogul Engines for the Iowa Central. Illustrated description of six new Baldwin locomotives designed for freight service. 1500 w. R R Age Gaz—Oct. 2, 1908. No. 95570.

New "Mogul" Type Superheated Locomotives. Italian State Railways. Drawings and description. 700 w. Mech Engr—Sept. 18, 1908. No. 95427 A.

Four-Cylinder Compound Locomotives, Danish State Railways. Illustrated description of an engine constructed on the Vauclain system, and of the "Atlantic" type. 1200 w. Engr, Lond—Sept. 18, 1908. No. 95412 A.

Pacific Locomotives for the Chicago & Alton. Illustrated description of five new locomotives differing from previous standard type in the use of Walschaert's valve gear and wagon top boilers with narrow fireboxes. 2500 w. R R Age Gaz—Oct. 2, 1908. No. 95564.

Pacific Type Locomotive with Narrow Fire Box. Illustrated description of Baldwin locomotives of this type with Walschaert valve gear and wagon top boilers with narrow fire boxes. 2500 w. Am Engr & R R Jour—Oct., 1908. No. 95540 C.

Pacific Type Locomotive for the Western Railway of France (Note sur la Machine "Pacific" de la Compagnie des Chemins de Fer de l'Ouest). Robert Dubois. Describes the conditions governing the choice of this type and the design adopted. Ills. 6000 w. Rev Gen des Chemins de Fer—Sept., 1908. No. 96112 G.

Locomotive Stoking.

The Advantages of the Automatic Stoker as Compared with Hand Firing for Locomotives. G. C. Grantier. Discusses both the advantages and defects. 2500 w. Boiler Maker—Oct., 1908. No. 95478.

Locomotive Tools.

Maintenance of Locomotive Tool Equipment. R. H. Rogers. Describes methods of keeping tool equipment up to the required standard. Comments by A. T. Sexton and C. L. Warner. 6000 w. Am Engr & R R Jour—Oct., 1908. No. 95539 C.

See also Management, under MISCELLANY.

Motor Cars.

A Railway Accumulator Car. Louis Dubois. Illustrated description of a new type of car in use on the Prussian State Rys. 1000 w. Elect'n, Lond—Oct. 16, 1908. No. 96046 A.

Steam Cars and Special Locomotives for Railways of Light Traffic. Abstract of paper read before the International Street Railway Union by Herman R. Von Littrow describing use of steam motor cars and other special equipment in Europe. 1600 w. Eng News—Oct. 8, 1908. No. 95747.

Petrol-Electric Motor-Car Traction on the Arad-Csanad Railway, Hungary (La Traction par Automotrices Pétrolés-Electriques sur les Chemins de Fer d'Arad-Csanad, Hongrie). Describes extensive motor-car traction for passenger trains on this important line, the motive equipment, and the results obtained. Ills. 4000 w. Génie Civ—Sept. 12, 1908. No. 96124 D.

Pneumatic Railways.

A Pneumatic Railway at Chicago, and a Review of Pneumatic Transportation Systems. Describes an experimental line, and review of systems. 2000 w. Eng News—Oct. 22, 1908. No. 96015.

Shops.

The Beech Grove Shops of the Big Four. William Forsyth. Illustrated detailed description of the large locomotive repair shops near Indianapolis, their equipment and methods of driving. 2200 w. Plate. R R Age Gaz—Oct. 30, 1908. No. 96236.

Improvements at the Works of the Kingston Locomotive Company, Kingston, Ontario, Canada. Henry Goldmark. Illustration, plans and description. 4000 w. Can Soc of Civ Engrs—Oct. 29, 1908. No. 96074 N.

Standardization.

See Management, under MISCELLANY.

Steam vs. Electricity.

Electric Traction vs. Steam Railroad Operation. W. H. Evans. Gives a general comparison between the two, and discusses matters of interest. General discussion. 9500 w. Pro Cent Ry Club—Sept., 1908. No. 96085 C.

Train Resistance.

The Predetermination of Train Resistance. Editorial discussion of resistance formulæ and applications. 1400 w. Elec Ry Jour—Oct. 3, 1908. No. 95597.

The Predetermination of Train-Resistance. Charles Ashley Carus-Wilson. Derives formulæ and verifies them by tests, giving practical conclusions. Also general

discussion. 35000 w. Inst of Civ Engrs, No. 3686. Dec. 10, 1907. No. 95489 N.

Wheels.

Car Wheel Stresses. George L. Fowler. Reviews the little known on this subject, urging investigations to aid in securing wheels for the requirements of modern service. 2000 w. R R Age Gaz—Oct. 16, 1908. No. 95964.

NEW PROJECTS.

Brazil.

The Madeira & Mamore Railroad. Description of second attempt to build a railroad in Brazil from Portovelho to Garupe. 1500 w. R R Age Gaz—Oct. 2, 1908. No. 95567.

St. Paul.

Progress on t' · St. Paul's Pacific Extension. Descrip. on of work on the line from Butte, Mont., to Seattle, Wash. Ills. 1200 w. R R Age Gaz—Oct. 9, 1908. No. 95753.

PERMANENT WAY AND BUILDINGS.

Construction.

The Building of the New Canadian Transcontinental Railroad. George C. McFarlane. An account of the location, organization methods and progress in constructing the Grand Trunk Pacific. Ills. 4000 w. Engineering Magazine—Nov., 1908. No. 96206 B.

Elevated Railways.

Raising an Elevated Railroad Structure under Traffic. Illustrated account of the raising of the Chicago and Oak Park Elevated R. R. 2400 w. Eng Rec—Oct. 3, 1908. No. 95615.

Chicago Terminal Transfer Track Elevation. Illustrated description of the elevation of two miles of line along 15th Place, Chicago. 2100 w. R R Age Gaz—Oct. 2, 1908. No. 95568.

Freight Sheds.

The Merchandise Terminal of the Atlantic Avenue Improvement, Long Island Railroad. Illustrated description of elevated freight structures. Ills. 2200 w. Eng Rec—Oct. 10, 1908. No. 95736.

Rails.

Some Special Designs of Rails and Tie-Plates. Brief illustrated descriptions f special features in standard designs. 800 w. Eng News—Oct. 15, 1908. No. 95959.

Life of Manganese Steel Rail on Curves —From Service Tests Made on the Elevated Division of the Boston Elevated Railway Company. H. M. Steward. 1500 w. Elec Ry Jour—Oct. 17, 1908. No. 95927.

A Test for Ascertaining the Relative Wearing Properties of Rail Steel. E. H. Saniter. A paper read before the Iron & Steel Institute describing a machine devised to determine the wear on a round test piece revolving at high speed. Ills. 1000 w. Ir & Coal Trds Rev—Oct. 2, 1908. No. 95848 A.

Station Heating.

Hot-Water Heating Arrangements for Passenger Stations. Abstract of a paper by J. P. Canty read before the New England Maintenance of Way Assn.; also discussion. 4200 w. Ry & Engng Rev—Oct. 10, 1908. No. 95811.

Stations.

Note on Diagrams Used on the Belgian State Railway to Facilitate the Determination of the Best Utilization of Platform Lines at Passenger Stations. L. Weissenbruch and J. Verdeyen. 3700 w. Bull Inter Ry Cong—Sept., 1908. No. 95688 G.

Tie Plates.

See Rails, under PERMANENT WAY AND BUILDINGS.

Ties.

Wood or Steel Ties (Holzschwelle oder Eisenschwelle). A. Haarmann. A discussion of their relative economy, claiming the advantage to be on the side of the steel tie. 2200 w. Stahl u Eisen—Sept. 2, 1908. No. 96138 D.

Track Construction.

The Cost of Track Laying. Discusses distribution of costs in new railway construction. 1400 w. Engng-Contr—Oct. 7, 1908. No. 95732.

Results Obtained with Slabs of Elastic Material Used as Bedplates in the Permanent Way. Ernest Müller. Description of the use of felt, leather and woven-fabric slabs. 1900 w. Bull Inter Ry Cong —Sept., 1908. No. 95690 G.

Tunnels.

Roadbed Construction of the New Bergen Hill Tunnel of the Lackawanna Railroad. Brief description of a new type of roadbed and track construction adapted to tunnels and subways. 900 w. Eng Rec —Oct. 17, 1908. No. 95938.

TRAFFIC.

Car Efficiency.

Car Efficiency. Arthur Hale. An account of the work of the committee on car efficiency, followed by discussion. 1500 w. Pro W Ry Club—Sept. 15, 1908. No. 95972 C.

Demurrage.

Freight Car Demurrage. Editorial on the value of demurrage bureaus. 2500 w. R R Age Gaz—Oct. 30, 1908. No. 96235.

Foreign.

Jurisdiction of the Interstate Commerce Commission over Foreign Commerce. Extract from a letter from Franklin K. Lane explaining ruling of the Commission requiring the publication of relative proportion of export and import rates to the Pacific Coast ports. 1500 w. R R Age Gaz—Oct. 2, 1908. No. 95563.

Freight.

The Freight Problem on Manhattan Island. Henry J. Pierce. An address before the N. Y. Traffic Club. 1700 w. R R Age Gaz—Oct. 30, 1908. No. 96238.

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Freight Rates.

Regulating Railroad Traffic. E. E. Clark. Address before the Am. Assn. of Freight Traffic Officers. Discusses conditions underlying the fixing of rates. 4000 w. R R Age Gaz—Oct. 2, 1908. No. 95562.

Passenger Rates.

The Legal, Economic and Accounting Principles Involved in the Judicial Determination of Railroad Passenger Rates. Maurice H. Robinson. Reprinted from the *Yale Review.* Serial. 1st part. 2500 w. R R Age Gaz—Oct. 9, 1908. No. 95757.

MISCELLANY.

Accounting.

Railway Accounting in Its Relation to the Twentieth Section of the Act to Regulate Commerce. Henry C. Adams. A consideration of the appropriate form of accounts for transportation agencies. 4500 w. Jour of Acc—Oct., 1908. No. 96075 C.

Objections to the Depreciation Charge. Memorandum of Am. Ry. Assn. special committee containing a summary of views of railroad officers on "depreciation" rules of Interstate Commerce Commission. 2200 w. R R Age Gaz—Oct. 2, 1908. No. 95566.

Arabia.

The Hedjaz Railroad. Illustrated description of the new sacred line between Damascus and Mecca built by the Turkish government. 2500 w. Sci Am Sup—Oct. 17, 1908. No. 95895.

China.

The Chan-Si Railroad, China (Le Chemin de Fer du Chan-Si, Chine). A. Millorat. Illustrated description of the line, structures, equipment, etc. Serial. 1st part. 5000 w. Génie Civil—Aug. 22, 1908. No. 95116 D.

Government Control.

The Relation of Railways to the State. W. M. Acworth. Address delivered to Economic Section of the British Assn. at Dublin. 7500 w. Engng—Oct. 16, 1908. No. 96059 A.

Enforced Railroad Competition. Ray Morris. Abstract of a paper in the Sept. *Atlantic Monthly;* discusses the evils and futility of enforced competition. 7500 w. R R Age Gaz—Oct. 2, 1908. No. 95569.

Great Britain.

The British Railway Position. An editorial letter. 2500 w. Ry & Engng Rev—Sept. 5, 1908. No. 94897.

Observations on British Railway Matters. Angus Sinclair. Reminiscences by an American locomotive engineer who has been a constant observer of British conditions. 1600 w. Ry & Loc Engng—Oct., 1908. No. 95542 C.

History.

Centenary of the First Passenger Train. An account of the trials made by Richard Trevithick. 1500 w. Engr, Lond—Sept. 18, 1908. No. 95416 A.

Management.

Some Good Ideas on Discipline. A report prepared by a committee and adopted by the C. & N. W. Op. Officers Assn. 1500 w. R R Age Gaz—Sept. 25, 1908. No. 95355.

Railway Maintenance-of-Way Organization. H. R. Safford. Abstract of paper in the *Purdue Engng Rev.* Outlines and examines an ideal organization, discussing the duties of officers. 3000 w. Eng News—Sept. 24, 1908. No. 95359.

Better Service at Reduced Cost. Raffe Emerson. A plan for handling locomotive supplies as an actually applied example of the simultaneous attainment of efficiency, standardization, and economy in railway operation and maintenance. Ills. Discussion. 12700 w. Pro N Y R R Club—Sept. 18, 1908. No. 95848.

Natal.

The Natal Government Railways. Description of properties with review of year 1907. 2400 w. Engng—Sept. 25, 1908. No. 95644 A.

Western Pacific.

The Western Pacific. George C. Lawrence. The first of a series of articles dealing with location and traffic, engineering and finances of the road. Ills. 4000 w. R R Age Gaz—Sept. 11, 1908. Serial. 1st part. No. 95000.

STREET AND ELECTRIC RAILWAYS

Accidents.

The Bournemouth Tramway Accident. Board of Trade report on an accident which occurred on May 1, 1908. 6000 w. Elec Eng, Lond—Sept. 5, 1908. No. 95633 A.

The Railway Accident in Berlin. Gives plan and particulars of the triangular crossing where the accidents on the Overhead and Underground Ry. occurred. 500 w. Engr, Lond—Oct. 16, 1908. No. 96062 A.

Caracas, Venezuela.

The Caracas Tramways. An illustrated description of the electric tramway system. 1500 w. Elec Engr, Lond—Oct. 9, 1908. Serial. 1st part. No. 95982 A.

Car Barns.

Car House Design. Describes recently built car houses which illustrate best American practice. Ills. 6000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95686 C.

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Report of the Committee on Operating and Storage Car-House Designs, Am. St & Int. Ry. Assn. Considers the problems to be met. Ills. 5500 w. Elec Ry Jour—Oct. 17, 1908. No. 95923.

The Gay Street Car House of the United Rys. and Electric Company, Baltimore. Illustrated description of a fireproof, reinforced-concrete building. 1100 w. Elec Ry Jour—Oct. 3, 1908. No. 95586.

Concrete Car House and Substation of the Seattle Electric Company. Illustrated description. 1000 w. Elec Ry Jour—Oct. 31, 1908. No. 96230.

Car Maintenance.

Report of the Committee on Economical Maintenance, Am. St. & Int. Ry. Assn. The subject of car equipment maintenance is considered. 3500 w. Elec Ry Jour—Oct. 17, 1908. No. 95924.

Car Reconstruction.

Rebuilding New Jersey Cars for Pay-as-You-Enter Service. Description of conversion of a large number of cars at Newark, N. J. Ills. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95675 C.

Car Repairing.

Special Shop Tools of the Twin City Rapid Transit Co. Illustrated description of special tools used in construction and repair work. 1400 w. Elec Ry Jour—Oct. 3, 1908. No. 95591.

See also Shops, under STREET AND ELECTRIC RAILWAYS; and Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Cars.

Side Entrance Cars in New Zealand. Account of Multi-side-entrance cars with plans and other illustrations. 400 w. Elec Ry Jour—Oct. 3, 1908. No. 95595.

Construction Details of New Combination Cars Built by the Northern Electric Railway. J. P. Edwards. Illustrated description of double-end combination baggage and express cars. 2000 w. Elec Ry Jour—Oct. 3, 1908. No. 95587.

Conductors.

Report of the Committee on Power Distribution, Am. St. & Int. Ry. Assn. Deals with feeders, working conductors, return and conduit systems. Ills. Includes paper by R. L. Allen. 4500 w. Elec Ry Jour—Oct. 15, 1908. No. 95921.

Economics.

Some Through-Running Problems and Their Solution. H. E. Blain. A paper read before the (British) Municipal Tramways Association; discussion and editorial. 6600 w. Elec Eng, Lond—Sept. 25, 1908. No. 95770 A.

Elevated Railways.

See Subways, under STREET AND ELECTRIC RAILWAYS.

Employees.

Employment of Trainmen. Discussion of the selection, training and discipline of electric railway employees. Methods used on various lines. Illustrations and typical forms. 10000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95680 C.

Treatment of Corporation Employes Incapable of Performing Ordinary Duty. H. Linsley. A paper read before the (British) Municipal Tramways Association; discusses superannuation funds and other methods used on British tramways. 2100 w. Elec Eng, Lond—Sept. 25, 1908. No. 95771 A.

Trainmen's Club Rooms, Benefit Associations, Pension Schemes and Other Welfare Work. Illustrated account of social betterment work on electric railways. 4000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95681 C.

Freight Traffic.

Freight and Express Traffic. Illustrated description of the development of freight and express traffic on electric railways in the United States. 9000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95683 C.

History.

The History of Mechanical Traction on Tramways and Roads. H. Conradi. Ills. 7000 w. Soc of Engrs—Oct. 5, 1908. No. 96093 N.

Interurban.

The Boyertown & Pottstown Railway. Illustrated detailed description of a line connecting two Pennsylvania towns. 2000 w. Elec Ry Jour—Oct. 24, 1908. No. 96024.

Lightning Protection.

Lightning Protection for Electric Railways. E. E. F. Creighton. A brief review of the general conditions of lightning protection. 2000 w. Elec Ry Jour—Oct. 14, 1908. No. 95919.

Locomotives.

The St. Clair Tunnel Single-Phase Locomotives. L. M. Aspinwall and J. Bright. Illustrated description of 66-ton locomotives used for handling freight and passenger trains. 1800 w. Elec Jour—Oct., 1908. No. 95843.

Motor Maintenance.

Report of the Committee on Maintenance and Inspection of Electrical Equipment. Gives the report of the standing committee of the Engineering Association. Ills. 21700 w. Elec Ry Jour—Oct. 14, 1908. No. 95920.

Operation.

The Application of Technical Science to the Construction, Maintenance and Operation of Tramways. R. G. and J. G. Cunliffe. Shows the utility of technical methods in examining their working. Suggestions for profitable research. 2800 w. Elect'n, Lond—Oct. 9, 1908. No. 95986 A.

The Application of Technical Science to the Construction, Maintenance, and Operation of Tramways. R. G. and J. G. Cunliffe. A paper read before the Mu-

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nicipal Tramways Association which discusses various problems in electric railway operation and suggests topics for research. Discussion and editorial. Ills. 6800 w. Elec Eng, Lond—Oct. 2, 1908. No. 95772 A.

Railless.

The Trackless Trolley System. T. Graham Gribble. Describes the principal features of the system, its working, etc. Ills. 4000 w. Tram & Ry Wld—Oct. 8, 1908. No. 95988 B.

Trackless Trolley Tramways. Abstract of a report of a Manchester commission on German systems. Ills. 1600 w. Elec Eng, Lond—Oct. 2, 1908. No. 95773 A.

Shops.

Car Repair Shop Design. General description of typical American car repair shops illustrating best practice. Ills. 6000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95687 C.

Signals.

A New Counting Signal System. Describes an improved automatic signal system. Ills. 1400 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95688.

Automatic Block Signals on the Boston & Worcester Street Railway. Account of a new type of signal controlled by an automatic track circuit. Ills. 1200 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95679 C.

Single Phase.

The St. Clair Tunnel Electrification. H. L. Kirker. Illustrated description of the installation of single-phase working in order to increase capacity. Also editorial. 4000 w. Elec Jour—Oct., 1908. No. 95842.

Thamshawn-Lokken Single-Phase Railway. Illustrated description of the first railway line in Norway to be converted to single-phase working. Elect'n, Lond—Sept. 25, 1908. No. 95779 A.

Electric Traction by Simple Alternating Current on European Railway. H. March-and-Thiriar. Account of recent progress in Switzerland, Sweden and Italy and description of various systems. Ills. 27600 w. Bull Inter Ry Cong—Sept., 1908. No. 95689 G.

See Locomotives, under STREET AND ELECTRIC RAILWAYS; and Railway Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Subway Entrances.

Ornamental Treatment of Berlin Subway Entrances. Description of various types of entrances. Ills. 500 w. Elec Ry Jour—Oct. 3, 1908. No. 95590.

Subway Lighting.

The Wiring and Illumination of the Hudson Tunnels. N. A. Cornell. Illustrated description of transformers, switchboards, conduits and fixtures of this large but simple system. 1400 w. Elec Wld—Oct. 10, 1908. No. 95874.

Subways.

The Paris Metropolitan. Describes recent extensions to the subway system. Ills. 2200 w. Elec Rev, N Y—Oct. 10, 1908. No. 95724.

Philadelphia Subway and Elevated R. R. J. A. Stewart. Illustrated description of Market street subway and elevated system. 2500 w. Munic Engng—Oct., 1908. No. 95524 C.

A Proposed Freight Subway Belt Line for Lower New York City. Francis W. Lane. Illustrates and describes the main features of the plan proposed by William J. Wilgus. Also editorial. 4000 w. Eng News—Oct. 15, 1908. No. 95955.

See also Underpinning, under CIVIL ENGINEERING, CONSTRUCTION.

Subway Signalling.

Automatic "Light" Signals in Park Avenue Tunnel. Description of system used since the electrification. Ills. 2000 w. R R Age Gaz—Oct. 9, 1908. No. 95752.

The Signalling System of the Subway and Elevated Division of the Phila. Rapid Transit Co. Detailed description of electro-pneumatic system. Ills. 3300 w. Sig Engr—Oct., 1908. No. 95820.

Automatic Block and Interlocking Signal System as Installed in the Hudson Tunnels. Jas. H. McCormick. Detailed description with diagrams and plans. Ills. 4500 w. Sig Engr—Aug., 1908. No. 95815.

Track Construction.

Standards of Track Construction. Illustrated description of standard practice in American cities. 3500 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95684 C.

Proposed New System of Street Railway Construction. C. B. Voynow. The system consists of a flangeless wheel, and a track built of a T-rail with a projecting flange above the tread. Ills. 4500 w. Elec Ry Jour—Oct. 17, 1908. No. 95925.

Train Dispatching.

Train Dispatching Methods and Forms of Train Orders. General discussion of American methods. Illustrations and typical forms. 5000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95682 C.

Dispatchagraph System. Account of a new system where the train dispatcher can set a signal at any desired station and receive a record of the time of interlocking. Ills. 600 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95678 C.

Trucks.

Motor and Trailer Trucks for the Denver and Interurban R. R. Co. Description of standard trucks for use on the Denver-Boulder line. Ills. 800 w. Elec Ry Jour—Oct. 3, 1908. No. 95594.

Wire Suspension.

Overhead Line Construction and Maintenance. Illustrated description of standard American practice. 7000 w. Elec Ry Jour—Oct. 10, 1908. Special No. No. 95685 C.

We supply copies of these articles. See page 579.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

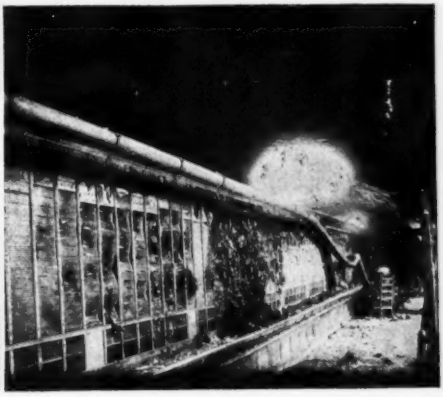
Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

The Burned Paris Exchange and Its New Equipment.

ON the 20th of last September fire completely destroyed the Gutenberg telephone exchange in Paris, causing a loss of several million dollars and crippling the business interests of all France. The Gutenberg exchange was a comparatively new building and had recently been equipped with a modern central battery switchboard. The workers, who for weeks had been installing the new equipment, were putting on the finishing touches and had ceased work for the night when the fire started. The fire was stubborn to fight, as it had gained considerable headway in the basement before the firemen arrived and the noxious fumes of burning insulation made the firemen's task a hopeless one. The accompanying views show how complete was the destruction of the switchboards.

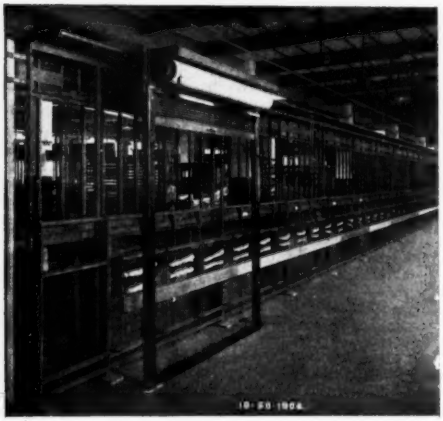
THE THIRD FLOOR OF THE PARIS EXCHANGE AFTER THE FIRE.



ON THE FOURTH FLOOR AFTER THE FIRE.

Telephone service in Paris had long ago become inadequate to meet the conditions imposed by the increased use of the telephone in the business and social activities of the city and the new central battery equipment was expected to do much toward relieving the congestion. In view of the urgency of the situation, work on the exchange was being pushed night and day, Sundays included. Under such conditions one can readily imagine the seriousness of having all means of telephonic communication stopped abruptly. With the burning of the exchange communicating facilities had practically dropped back thirty years and the telephone officials, realizing the gravity of the situation, exerted every effort to restore the interrupted service as quickly as possible. The telephone officials lost no time in taking up the matter of replacing the burned equipment. They communicated with the Western Electric Company on Septem-

ber 21st, the day after the fire, for an emergency outfit. The return cablegram suggested an emergency outfit with a capacity for 9,600 subscriber lines. Full information as to exactly what the Paris officials had decided upon in the way of switchboard equipment was not received in New York until over two weeks after the fire. The specifications called for a central battery multiple switchboard of thirty-two sections equipped for 10,000 subscribers' lines and having an ultimate capacity for 10,400 subscriber lines. The thirty-two sections were also equipped with 1,800 trunk lines, but provided for an ultimate capacity of double this number. Relay and cable racks and an intermediate distributing frame for 11,000 lines were also included in the order. The outfit had to be completed within one month from October 2nd.



REAR VIEW OF THE TELEPHONE SWITCHBOARD.

Five days after work on the switchboard was started, its metal frame was erected complete, on the floor of the wiring department. At this point the woodworking and wiring departments commenced work simultaneously. While this part of the job was being rushed along in one department, in another the switchboard cabling was being made, cut and soldered in place. Twenty-four men were started on this job, but the number of men and the amount of time per day devoted to this work were gradually increased until two weeks later, when the switchboard was complete and ready for shipment, there were sixty-five men soldering all day and up to a late hour each night.

The relay and cable racks and the intermediate distributing frame were made in less than a week and forwarded as soon as completed because an early shipment of this part of the outfit was specially requested from Paris so that its installation could be commenced as soon as possible.

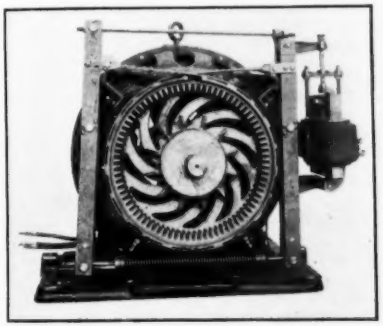
The Paris officials also took up with the Western Electric Company the purchase of switchboard cable for additional wiring. Two days after this order was received 135,000 feet of cable had been unreeled, the ends paraffined, the cable rewound on the reels, packed in cases lined with oil-cloth and started on its journey eastward. Altogether, the new equipment supplied by the Western Electric Company for the Gutenberg exchange amounted to about nine carloads. The switchboard alone measured over 150 feet in length and will require ninety operators. The cable wiring on the board amounted to 15,595,859 feet or 3,000 miles of single conductors, and over two and one-half miles of switchboard cable was forwarded separately for additional wiring. An expert was sent by the Western Electric Company to Paris to take charge of the installation.

A. C. Motor Friction Brakes.

IN many applications of electric motor drive the quick and accurate stops necessary could not be made without the use of suitable brakes. Brakes also serve to prevent accidents by automatically stopping and holding the load in case of failure of the current supply from any cause. A number of magnetically operated direct current motor brakes have been designed, but electro-magnets using alternating current require a considerably greater expenditure of energy for a given braking effect than those using direct current. Moreover the fly wheel effect of the rotors of alternating current motors is greater than that of direct

current motors of corresponding capacity. Again, the magnet core must be laminated when alternating current is used and the cost of construction thus increased. It is largely to these facts that there are so few successful alternating current motor brakes.

A type of alternating current brake which satisfactorily overcomes these difficulties has just been placed on the market by the Westinghouse Electric & Mfg. Company, Pittsburgh. This brake is characterized by simplicity and strength in construction, and reliability in action; it is self-contained, and is readily applied and easily adjusted. It is operated by electro-magnets.



The brake referred to, designated as the "PB" type, is intended for use on Westinghouse two and three phase induction motors of from 5 to 100 horse power, 25, 40 and 60 cycles. The braking action depends on the contraction of a coiled steel spring.

The advantage of this construction is that the brake will operate equally well with the motor tilted at a considerable angle from the horizontal position, as on roller lift draw bridges. The construction is shown in the illustration. The cast iron brake shoes are held against the brake wheel by steel bands. The two vertical pivotal brake beams are connected at the top by a tie rod and at the bottom by a coiled steel spring; and a polyphase solenoid operating magnet is attached to the brake beams by a lever. The ends of the brake bands are attached to the beams above the pivots: the spring tends to draw the lower ends of the beams together, thus drawing the band and shoe against the wheel.

The friction of the wheel against the shoes tilts the beams through a small angle until they strike against lugs on the frame work. These lugs are above the pivots and are so placed that when the beams press against them the tops are separated and the brakes more firmly set by the motor itself. A very heavy breaking action is thus obtained with a comparatively light spring and magnet. When the motor is operating, the current passes through the coils, the core is pulled down, the brake is released and the spring elongated. On stopping the motor the brake circuit is opened, allowing the spring to contract and apply the brake.

Accurate Cost-Keeping.

I CONFESS to a certain admiration for the factory manager who, with the nerve of a gambler, examines one of the products of his plant, 'hefts' it, decides that the material in it probably cost about seventy-five cents, mentally 'calculates' that the labor must have amounted to about three dollars, entirely ignores the matter of 'expense,' and decides that 'we can afford to sell that for ten dollars.' He is willing to take a chance on a few hundred at that figure, and, of course, if competition arises, the selling price is cut to meet it—in the same gambling spirit.

"But a limited vocabulary fails to supply words suitable to express my appreciation of the manager who would deliberately take a set of records known to be erroneous and further falsify and mutilate them to force balances, then use such records in building up an elaborate system of accounts, paying salaries to thirty clerks to help do it, in an effort to deceive himself into the belief that he was thus learning the cost of his products."

The above words are from the pen of Mr. Henry Abbott, president of the Calculagraph Co. It is to do away entirely with such methods and to arrive at an absolutely correct printed record of time and costs that the Calculagraph was de-

signed. This little machine possesses the almost incredible faculty of printing automatically the starting time and calculating automatically the elapsed time consumed in any particular transaction or job. By the use of a machine which only prints the time of day the workmen commence and finish a job, the figures must be copied laboriously and one record subtracted from the other to tell how much time is expended upon each operation. Such a system is cumbersome, expensive and liable to clerical errors in subtraction. There is also the constant danger of transposition or mixing figures while posting or transcribing items from job cards or sheets filled with a

mass of confusing figures representing job numbers, workmen's numbers, and times of starting and of stopping.

The Calculagraph not only records the time of commencing and the finishing time, but eliminates all brain work by doing the subtracting and printing the elapsed time on the job ticket or card at the time the job is finished. The Calculagraph, in other words, makes possible the obtaining of the exact labor cost without any liability of error, and one machine will keep the records of all of the men in a large department.

The mechanical features which make it possible for the Calculagraph to complete the record by calculating the elapsed time are very interestingly described in pamphlets issued by the Calculagraph Co., 1411 Jewelers' Building, New York, who will send them on request.

Machine Tool Controller.

THE self-contained drum type machine tool controller here illustrated is a recent addition to the line of electric controlling devices designed for use with motor operated machine tools.

It possesses the advantage of combining in one compact piece of apparatus the speed regulating mechanism and the resistance, instead of constructing these separately and requiring connections between the two to be made after the apparatus is installed.

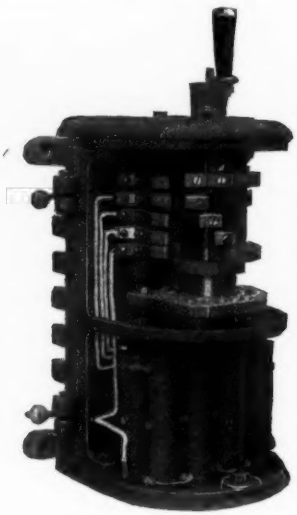


FIGURE 1.

Figure 1 is a front view of this new type of controller and shows the removable resistance units mounted in the lower half of the controller with insulated wires running from each unit to the metal "fingers" in the upper part of the device. These units constitute the armature resistance and are employed for starting duty only.

Figure 2 is a rear view of the same drum and shows another type of resistance unit—also removable—mounted on

the back of the controller. The four units shown in this view constitute the field regulating resistance and are divided into 20 steps, providing a range of speed variation of 2 to 1 or 3 to 1.

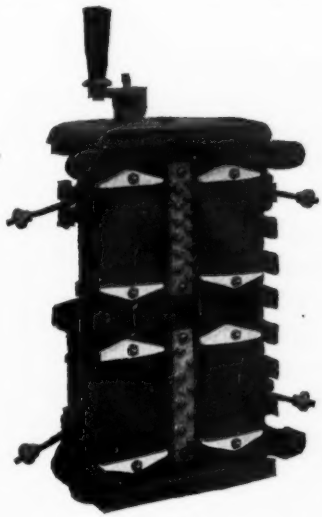


FIGURE 2.

These controllers are made for both reversible and non-reversible motors ranging from 1 to 7½ h.p. and are designed for use on either 110 or 220 volt direct current circuits. They are made by The Cutler-Hammer Co., Milwaukee.

Copper and Metal Gaskets.

THE leaks in flange joints, unions on steam boilers, steam engines, steam pipes, apparatus, etc., are partly due to faulty construction of the joints or couplings, unsufficient strength of the flanges and covers, imperfect, rough, very uneven, deeply corroded surfaces, or to the said surfaces being out of parallel. An insufficient number of coupling screws, or the placing of the same at uneven distances or too far from each other, may likewise cause leaks. Leaks may, furthermore, be caused by rigid piping, *i. e.*, piping which cannot sufficiently expand and contract, as well as by piping and other appliances which do not have a sufficient slope to allow the condensed water to run off and are consequently subject to water hammer and the excessive pressure resulting therefrom. The chief cause of leaks, however, is to be found in the use of packing material incapable of continuously withstanding the influence of high temperatures, steam, water, high pressure gases and acids.

The Goetze copper and metal gasket here illustrated provides a packing material which will comply with all requirements. They are so arranged as to present a surface that conforms to every irregularity in the flanges, while effectively resisting high pressure and temperature.

Through the use of elastic copper and metal gaskets on flange joints, it has become possible to use long distance conduits for steam under pressure exceeding 15 atmospheres, the joints being thus kept tight for a number of years with only occasional inexpensive repairs.

These gaskets are not only adapted to all possible purposes—such as marine, locomotive and portable engine boilers, tubular boilers and their joints, boilers for steam boiling, and for manhole, handhole and mudhole covers—but possess all the advantages of simplicity, ease of adjustment, cleanliness and absolute safety of operation. Repairs, when necessary, are made in the shortest possible time.

The American Goetze-Gasket and Packing Co., 519 East 149th street, New York, will be glad to furnish further information regarding these gaskets upon request.

F. & S. Record Outfit.

THE latest example of the manner in which photography is being introduced into commercial fields is the record outfit, manufactured by the Folmer & Schwing Division of the Eastman Kodak Company, Rochester, N. Y.

This outfit was primarily designed for making copies of insurance and real estate documents, but its operation is so simple, inexpensive and effective that it is being rapidly adopted by manufacturing plants for making copies of drawings, illustrations, documents and, in fact, every kind of transcribing.

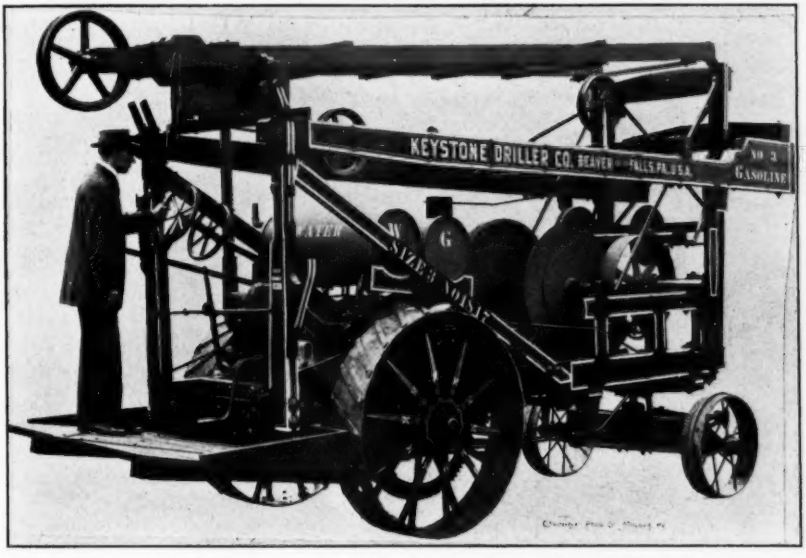
The drawing or record to be photographed is placed on a horizontal platform which may be raised or lowered by turning a wheel located at the back of the cabinet. This adjustment regulates the size of the copy. A bromide paper roll holder is attached to the back of the camera and the image projected direct on the paper, a prism reversing the image so that all printed matter reads from left to right in the usual manner. The roll holder is equipped with registering and perforating device which enables the operator to determine how much paper has been consumed, and also where to cut apart the sheets for developing.

One of the strongest features in favor of the record outfit is its absolute accuracy, every mark appearing on the copy being precisely as it is on the original. Another strong feature is the fact that the drawings, tracings, etc., may be all copied to standard size for filing and the operation requires but five or six seconds.

The machine does not require the attention of a photographic expert as its operation is extremely simple.

Gasoline Driven Drilling Machine.

THE accompanying illustration shows a gasoline driven driller recently brought out by the Keystone Driller Co., Beaver Falls, Pa. Heretofore the ideal motive power for drilling machines has been the steam engine, but there are many localities where fuel and water are so scarce and expensive as to prohibit its use. The aim has been to produce a machine in every respect equal to a steam driller. In fact, they simply take their Nos. 3 and 5 steam drillers, both traction and non-traction, leave off the steam engine and boiler, etc., and, without other change, equip them with gasoline motors and a peculiar and specially devised power transmission.



The engines are of the two-cylinder type with piston so opposed to each other in the crank that the crank shaft receives an impulse at every revolution. In this way one piston counter-balances the other so that there is practically no vibration to the engine.

The crank shaft bearing and pistons are completely enclosed against dust. The entire internals of the engine are conveniently removeable through a covered aperture in the engine frame.

This construction of engine permits of the greatest possible lightness and strength at the same time and allows the lubricating to be done by the splash system from a quantity of oil in the crank shaft pit, thus avoiding all necessity for grease cups or oilers for pistons or crank shaft bearings and at the same time automatically securing the most perfect lubrication possible. The tendency of the lubricating oil to leak outward to waste through the main bearings of the engine is obviated by a simple check valve. The cylinders and truss of the engine are cast in separate pieces so that in case of possible injury to any one of them it can be replaced at small expense.

The engines are governed perfectly by a reliable fly ball type of throttling governor, driven direct by the engine without belts or any perishable device and will maintain a uniform speed of the engine at all times, requiring no attention from the operator. The constant speeds of the engine can be changed instantly at the will of the operator and will remain exactly where left. It is impossible for the engine to get away from the control of the governor, thereby running away and wrecking the machine by bursting fly wheels.

The machine is provided with a regu-

lar automobile type front axle and steering device. This axle is much stiffer than the old style axle. The steering mechanism is of the regular worm and sector self-locking type and is controlled by a steering wheel at the rear of the machine, and is operated nearly as easily as that of a large automobile. One and a quarter revolutions of the steering hand wheel is sufficient to throw the steering wheels from straight ahead to the extreme right or left. This machine will turn in a much smaller circle than the old style outfit. An emergency brake is placed on the left hand side of the machine near the steering and control wheels at the driver's seat.

The manufacturers will be glad to send further particulars upon request.

Drill Chucks.

THE illustration shows the latest improvement of the Almond drill chuck. The body of the chuck is recessed to receive a pinion which meshes with teeth cut on the front of the geared nut. The pressure on the nut

being at the back, the same wearing surface is preserved as in the former chuck of this make. A cap covers the pinion and provides a support for the outer end of it, while the inner end of the pinion has a bearing in the body of the chuck. Both the pinion and the nut are made of a special grade of tool steel tempered. There are no projections on the chuck, the pinion comes flush with the surface of the chuck body and has a square hole in it to fit the key. The nurled sleeve can, as formerly, be used for quick adjustments while the key is used for final tightening.

This chuck is made by the T. R. Almond Manufacturing Co., Ashburnham, Mass.

Electric Time Recorder.

THE Bristol new electric time recorder was designed to meet the widespread demand for a simple and practical instrument to record automatically the occurrence and duration of various

FIG. I.

operations, such as the starting and stopping of machines, the opening and closing of valves, the duration of runs, the passing of trains, etc., etc. With this recorder it is possible to record several different operations on the same chart and the recorder may be located a long distance from the points at which such operations occur.

These recorders have already been used in connection with machinery to show when the machines were started and stopped, how long they remained

idle, and just when they were started again. Fig. 2, is a reduced cut of the record chart showing complete 24 hour records of operation of two paper machines. This record shows the time and duration of each break and also the time required to wash the felts and put on new wires.

One of these recorders arranged to record operations at six different points is shown on Fig. 1. Each one of the six pens shown on this instrument makes an independent record, continuously and automatically, and in this way six different operations may be recorded on the same chart. Each pen is actuated by an independent electro-magnet and the battery-circuit, so arranged that closing the circuit causes the pen to move a certain distance on the chart.

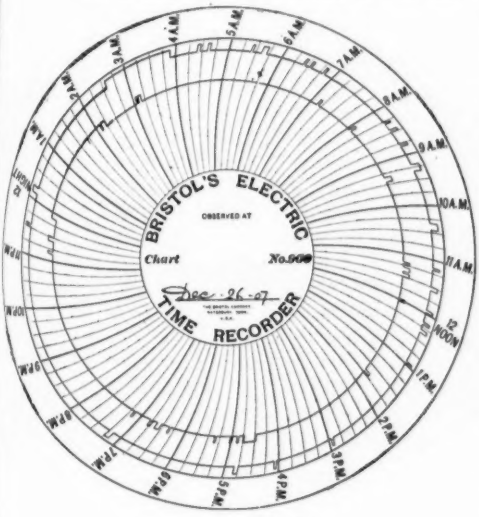


FIG. 2.

Binding posts are provided at the base of the recorder, to which pairs of small lead wires are attached. These wires may be of almost any desired length, it only being necessary to have the object whose motion is to be recorded open and close the circuit whenever the motion occurs.

These recorders are usually operated by a battery-circuit, but any convenient circuit may be employed by the insertion of lamps or other resistance to reduce the E. M. F. across each electro-magnet. The object whose motion is to be recorded is caused to make and break this circuit through any convenient contact.

The Bristol Company, Waterbury, Conn., are the manufacturers of these recorders.

Single-Geared Crank Shaper.

MODERN methods in shop practice, and the present extensive use of special high-speed tool steels, have made the ordinary shaper of the past entirely inadequate to meet the demands of present day practice. The shaper, heretofore regarded as essentially a tool-room machine, has been made a manufacturing machine. To meet these changed conditions and new demands, The American Tool Works Co., Cincinnati, have built a line of extra heavy and powerful shapers.

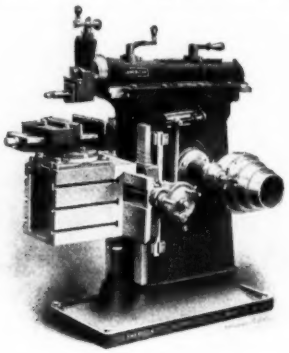
The column is unusually deep and wide, while the base is of large proportions. The ram is very heavy and is designed for uniform rigidity throughout entire length of stroke. The stroke of the ram is positive and has four rates of speed, ranging from 20 to 65 strokes per minute. The shaper here illustrated is fitted with an automatic stop which releases the feed and thus prevents breakage to parts when the tool is fed into the cut or should the apron be accidentally fed to its limit in either direction on the rail.

The rocker arm is made double section at the top and this, with the large opening through the column, permits a shaft 2½ inches in diameter to be passed under the ram for keyseating. The vise is of new design throughout and is of heavy pattern.

Special attention has been paid to the thorough lubrication of all the working parts, thereby insuring long life and satisfactory service from the machine. The countershaft has tight and loose pulleys 12 inches in diameter by 3½ inches face, to run 180 revolutions per minute.

All gears are cut from the solid with special cutters and are coarse pitch and wide face. Bevel gears are planed from the solid. Pinions in driving train are cut from bar steel. Easy access is pro-

vided to all working parts through the large door on the rear side. All bearings are extra wide and scraped to surface plates. All running bearings are bushed to permit relining in case of wear. The bearing for driving pulley is massive and cast integral with column

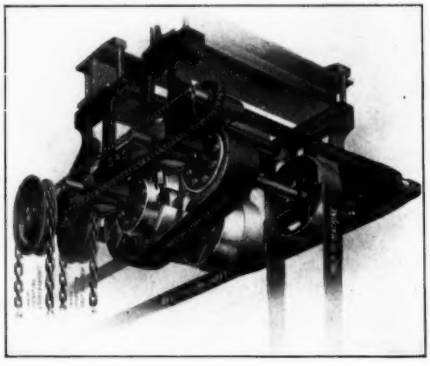


and is exceptionally long, extending well into the center of cone, eliminating the necessity of an out board bearing for the cone shaft. This bearing is bronze bushed. All shafts are of high carbon crucible steel, accurately ground. All points of danger are amply covered to prevent injury to operator.

The S. & S. Variable Speed Countershaft.

THE accompanying illustration shows a device which is being manufactured by the Rotary File & Machine Co., 589 Kent Ave., Brooklyn, N. Y. Every manufacturer knows there is a leakage in profits through his inability to run his machines at just the limit speed suitable for the job on hand, but unlike a leaky joint in a steampipe, it does not command attention by constantly reminding him of its existence. With the step cones you cannot get an absolute speed, as the speed you require is almost invariably somewhere between the steps, while true cones, although extensively used, are not really practical for the transmission of power. They are heavy and bulky, and the strain on the transmission belt is abnormal and destructive. There is no give to the pulleys, and the belt, to be of any service, must be repeatedly taken up and maintained at high tension; and they absorb a tremendous lot of power.

The S. & S. variable speed countershaft consists of an arrangement of expanding belt operating pulleys by means of which any variable speed relationship desired within the limits of 4—1 can be maintained at its maximum and capable of ready adjustment at a moment's notice. The gear is made in fourteen standard sizes, capable of transmitting up to 128 h. p. The variation in the diameter of the expansion pulley is effected in the following way: It will be noticed that the rim is divided into twelve sections with two spokes riveted to each. These spokes slide in machined slots inside a cast iron hub. Part of each spoke inside the boss has teeth milled on one edge and all are in mesh with a broad pinion. This pinion is operated by an inner shaft which is only capable of longitudinal movement, but owing to grooves being milled on the one end of this inner shaft, any movement given to same rotates the aforesaid



pinion inside the hub drawing the spokes in or forcing them out according to the direction of motion given to the hand wheel which operates both of these inner shafts simultaneously.

The manufacturers make the following claims: Ability to transmit any amount of power and vary the speed at a ratio of approximately 4—1; that expansion pulleys are the only ones that make possible an efficient short drive;

no expensive special belts; gears are adaptable for mounting on girders, ceiling, wall or floor; every part of the device is designed to be sufficiently substantial to withstand abnormal strains; and each size takes up the minimum amount of space consistent with the amount of power handled by each.

Economy Tests of High Speed Engines.

IN a paper read by C. H. Treat at a recent meeting of the American Society of Mechanical Engineers and printed in the October Proceedings, complete data are given on a test made July 9th and 10th of this year on a 7 x 7 vertical self-oiling engine which had been run almost continuously night and day for 10,000 hours connected to a forced draft fan. The engine cylinder had been badly scored and the mean diameter increased to 7.082 in. The rings had been broken due to water and were replaced prior to test. The dotted line on the curve (Fig. 1) shows the results of as low as 41 lbs. per i. h. p. per hour under full load.

The data for the full line curves in Fig. 1, showing results for engines in proper condition, were obtained from tests made at the plant of the American Blower Company, Detroit, in 1905. The test was made by condensing the exhaust in a surface condenser consisting of a steam heater section pipe immersed in a tank, having an overflow and one pound supply from city water. The whole was up overhead so that any drip or leaks could be seen and stopped. That the section itself did not leak at any time was shown by the entire absence of drip, unless steam was entering.

The condensation being piped down, the heater pipes and base were slanted to drain through a water seal to prevent steam blowing into the upper of two barrels having drain valves at bottom, the lower barrel being on platform scales. For each barrel of water the weight before filling was subtracted from the full weight. The indicator spring was calibrated by both makers and the American Blower Company. A long lever reducing motion was used to

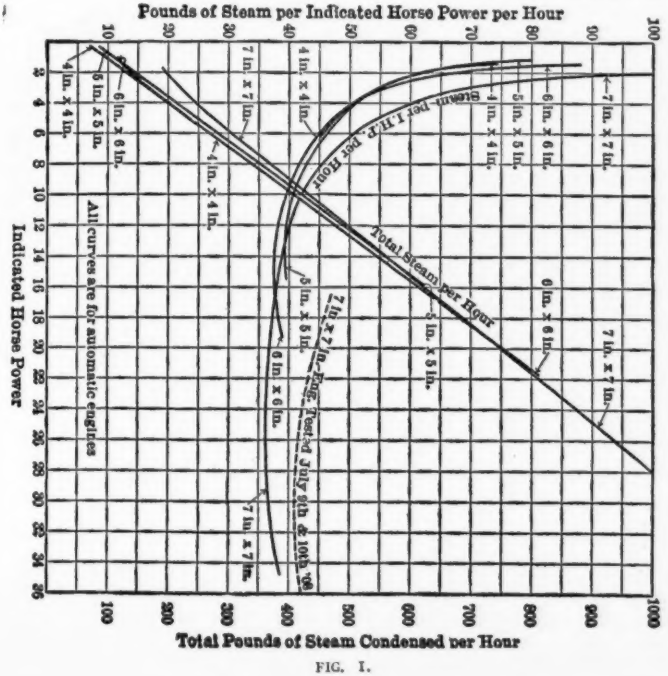

Pounds of Steam per Indicated Horse Power per Hour
Indicated Horse Power
Total Pounds of Steam Condensed per Hour
All curves are for automatic engines
Total Steam per Hour
Steam per I.H.P. per Hour
7 in. x 7 in.
6 in. x 6 in.
5 in. x 5 in.
4 in. x 4 in.
Tested July 9th & 10th, '06

FIG. 1.

prevent lost motion. The drum spring was drawn tight, and at the high speeds cards were short. The engine was indicated at speeds up to 500 r.p.m. using a Prony brake at high speeds and taking the brake horse power.

Readings were taken every five minutes after conditions had become constant and the engine was well warmed.

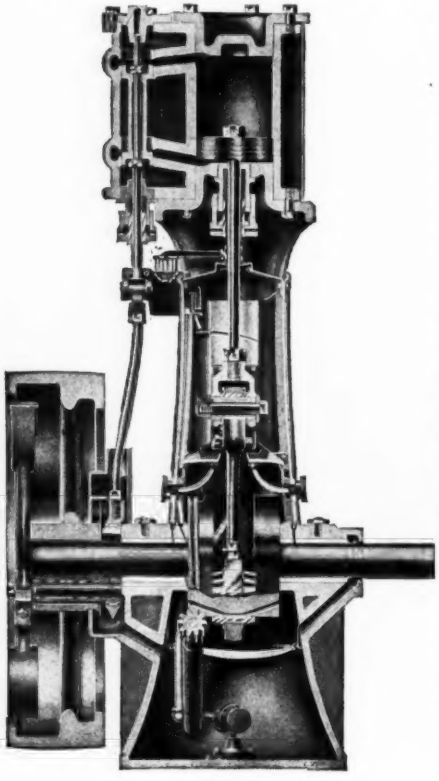


FIG. 2.

No corrections were made for moisture in steam, but a few determinations show a quality of 98 to 99 per cent. Data given in Fig. 1 are from tests of a number of engines for most sizes, the speed being 350 to 500 r.p.m., though some were at somewhat lower pressures.

Fig. 2 gives a section of "ABC" engines showing arrangement of cylinder and valve chests and the oiling system. Mr. Treat's test of the used engine gave the indicated friction horse power as 1.18, this being only 4 per cent of the I.H.P. of the engine. The oiling system must receive much credit for keeping the internal friction at such a low percentage.

Centrifugal Air Compressors.

OWING to the great demand for moderate pressure air compressors for industrial air blast and exhauster service the General Electric Company, Schenectady, N. Y., has carried out during the past few years a series of exhaustive experiments on the centrifugal type and is now prepared to furnish a line of standard centrifugal air compressors with pressures rated from .88 lbs. to 4 lbs. per square inch, and in capacities from 750 to 10,000 cubic feet of free air per minute.

The centrifugal air compressor consists essentially of a rotating impeller surrounded by a suitable casing with an intake opening at the center and a discharge opening at the circumference. In appearance, and in operation it is similar to the well-known centrifugal pump, the efficiency depending largely upon the design of the impeller and casing and on the proper shaping of these parts. These machines are of sturdy construction and will operate under adverse conditions with a very low cost for maintenance. A successful compressor of this type necessitated a thoroughly reliable high speed driver. For this purpose standard turbines have been used in many cases and standard turbo-generators have been utilized as direct current motor drivers with but slight change. Compressors driven by induction motors are also available. Figs. 1 and 2 show the representative types of turbine and motor driven compressors.

These motors are of construction similar to the generators used in turbo-generator sets. Commutating poles and shrunk-ring commutators are used so that sparkless commutation is insured. Each direct current motor is furnished with a suitable rheostat, so that adjustment of pressure can be obtained by changing the speed. The turbines used for these sets are of the Curtis type. Under the same conditions of service

the steam consumption compares favorably with that of the best reciprocating engines. Slight speed variations can be readily made so that changes in pressure are easily obtained. Turbine driven sets can be furnished for non-condensing operation and sets above 50 horsepower can be furnished to operate condensing, if desired. These turbines are adapted for steam pressures from 100 lbs. to 175 lbs. The induction motors are furnished with the well-known squirrel cage type of rotor. Since the speed of this type of motor cannot be varied, care must be taken to specify a pressure sufficiently high to cover the operating requirements, because at constant speed the pressure cannot be varied without altering the design of the impeller.

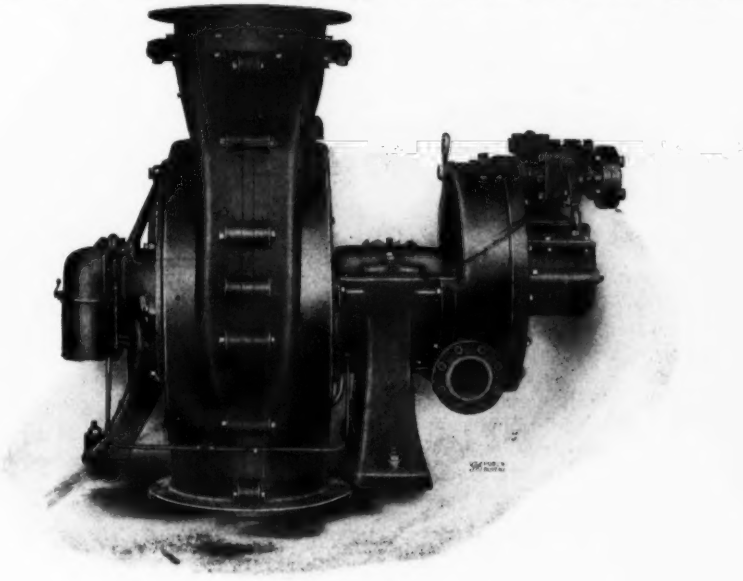


FIG. I.

As in the case of centrifugal pumps, the pressure depends on the peripheral velocity or rim speed of the impeller. Increased pressure can be obtained by increasing the speed. The volume of free air is, however, limited to the capacity of the driver and hence must be reduced proportionately to the increase in pressure, otherwise the driver might become overloaded.

The pressure in the mains leading from the compressor is entirely free from pulsation and practically constant for all volumes within the rated capacity of the compressor. Contrary to the results obtainable with positive pressure blowers, the power required to drive centrifugal compressors varies approximately with the volume of air delivered when operating at a constant speed. This fact gives a greater flexibility and improved economy to the centrifugal type where variable loads are required, satisfactory efficiency being obtained between the limits of 25 per cent. and 125 per cent. of the rated load.

For foundry cupola service the direct current motors can be compound wound so as to automatically increase the speed should the volume of air delivered decrease, thus increasing the pressure of the air and preventing undue reduction of flow of air through the cupola when it chokes up.

Since the pressure developed is practically constant from no load to 25 per cent. overload, as is shown in Fig. 3, these compressors are well adapted for constant pressure work as in gas or oil

furnace service. For this service one large compressor may be installed in a central location with distribution mains running to the different furnaces. For ordinary gas or oil furnaces the rated pressure of 1.7 lbs. should be sufficient, although for furnaces requiring a concentrated or positively directed jet, 2.7 lbs. rated pressure may be desirable.

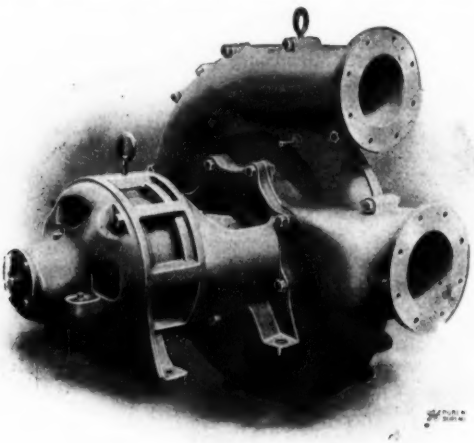


FIG. 2.

The centrifugal compressor has many distinct advantages over other types. These compressors are exceedingly simple in design and efficient throughout the working range. The only wearing parts are the bearings, hence nothing can get out of order. Furthermore, neither gearing nor belting is required. There is also a great advantage where a variable volume is required at constant pressure, as this is a characteristic which is inherent in a centrifugal compressor without change of speed or appreciable loss in efficiency. In the displacement type of compressor at constant speed, however. the pressure drops rapidly with the output above a certain point, and the volume is limited by the size of the cylinder and the speed.

For use in smelters, these compressors are admirably adapted. They can also be used to advantage in sulphite pulp mills' and in connection with chemical works where a small degree of vacuum is required.

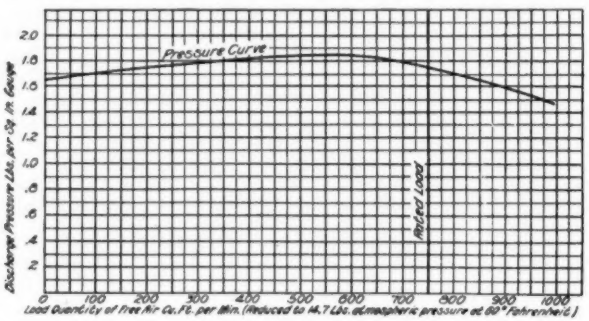


FIG. 3.

Organ Blowers.

ONE of the earliest applications of the electric motor was the driving of organ blowers. As all these blowers were formerly of the bellows type, the simplest method of using a motor was to cause it to drive a crank which operated a slotted arm attached to the bellows. This scheme was very satisfactory so far as obtaining a current of air was concerned; but usually resulted in considerable noise. In spite of this defect, however, there are still a large number of small organs so equipped.

During the past few years there have come into use organ blowers constructed on the same principles as centrifugal blowers used for ventilation. The continuous rotary motion of the electric motor has not only made their use possible, but has made them the preferable type for this kind of drive.

The accompanying illustration shows one of these blowers of large size driven by a C-W motor, built by the Crocker-Wheeler Co. of Ampere, N. J. This blower in addition to being of the fan type, is so constructed as to be absolutely noiseless, even when run at high pressure. There are no bearings except those of the motor itself, which results in a very considerable saving of power. No rheostat or other device for regulating current is required, which results in additional saving, as the air supply and current consumption are regulated automatically by the amount of air required by the organ at any moment.

For high pressures a multi-stage or compound blower is used, which is so built that there is no interruption to the continuous motion of the air in passing from one stage to the next. This not only effects a saving in power, but reduces to a considerable extent the heating of the air. The blower is entirely of steel.

Abuse of Modern Roads.

A SHORT time ago there appeared in the columns of the New York *Tribune* a cablegram to the effect that the French Minister of Public Works proposed to abandon the use of tar on their thoroughfares and repave them in the old fashioned manner. The reason given was that the fine particles of the tarred surface thrown up by automobile traffic is killing trees and other vegetation along the highways so treated. The *Good Roads Magazine* made an investigation of the subject, and in their issue of October published an article which contains the opinions of some of the leading road authorities in this country and abroad, and summarizing editorially said:

"It is to be doubted that this report tolls the death knell of tar and its compounds and refinements, and similarly of oil and other treatments for road making and dust suppression.

"To assert that any particular kind of pavement or surface treatment that has done good service for years has become worthless under the new method of traffic is as ill-considered as to insist that this or that pavement is the best for all purposes. Either argument assumes that

all conditions in road building are everywhere equal and is based upon a wrong premise.

"Where there is much heavy trucking, for instance, and the question of noise is subsidiary, a pavement of granite blocks on a concrete foundation is frequently found to serve the purpose best. Where such questions as noise, sanitation, dust, skidding, slipperiness, resilience, cost of availability of material predominate, there are other methods of road-making which are found to be entirely satisfactory.

"That the automobiles in the immediate neighborhood of Paris travel at a speed that destroys the road surface and, in so doing the bordering vegetation is destroyed does not necessarily condemn the pavements. A recent report stated that pebbles from an ordinary roadway were whirled into second-floor windows of houses on the line of roads subject to such traffic. Other reports call attention to scattering of disease germs and to the damage to fruit and foliage along rural roads from the dust that is raised by speeding motor cars.

"Repaving, 'in the old fashioned manner,' as the report referred to reads, will not solve the problem, for the trouble is not so much with the roads as with the abuse of the roads in transforming them into speedways.

If one stops to consider what would be the effect of rolling a grindstone over a road as a child rolls a hoop, and, then, the effect of the same grindstone heavily weighted and driven from the axle at the top speed of a 60-horse-power engine, he appreciates the difference in action between a drawn and a propelled wheel—the fore wheels of an automobile do small damage to the roads; it is the rear wheels, through which the power is exerted that 'make the dirt fly,' and cause an abrasion of the road surface entirely different from that of drawn vehicles. The damage to the roads has been proven, however, to come from cars exceeding a 20-mile speed.

"On the list of ordinances of most of the older communities in the country there is to be found a law forbidding driving horses at an excessive speed; such laws are, to-day, practically obsolete because the horseman who seeks a test of the ability of his animal resorts to a race-track. When the bicycle came into use it was employed almost entirely for speeding; it has become a utility, now, and the racing is confined to tracks arranged for that purpose. It may be predicted with reasonable certainty, therefore, that the time will come when the motorist, if he wishes the exhilaration of a race will betake himself to a speedway especially adapted for that purpose, and that the public highways will be relieved from the damage done them at present by the excessive speed of motor cars."

Fuel Economy and Forced Draft.

IN a recent address before the Modern Science Club of Brooklyn, N. Y., L. J. Wing, president of the L. J. Wing Mfg. Co., of New York, drew attention to the advantages and economy of forced draft. The Wing turbine blower is a combination of the old type of fan and steam jet blower. "It gives the steady even pressure of the fan and the benefit of a small per cent. of steam thoroughly mixed with the air. The blower is placed in the wall of the boiler, takes up no room and requires no further attention than the filling of the oil cup once a day. Each boiler has its own blower, and undoubtedly gives the best combustion ever obtained from any system.

"A strong draft by a tall chimney necessarily requires a great amount of heat in the stack to make the draft. The heat going out of the stack is an absolute waste. On tests made in a large plant in Brooklyn having Wing's system of forced draft, a stack nearly 500 feet high showed the gases 84 degrees lower when the blowers were in use than with the natural draft, while the saving in fuel was over 18 per cent. and the boilers gave 50 per cent. additional power; at the same time the grates and tubes were kept in better condition than with natural draft.

"With a strong natural or induced draft making a vacuum in fire and combustion chambers, the tendency of the air or gases is to take the most direct

route from inlet to outlet, leaving a large portion of the shell or tubes out of the current, and, therefore, all parts are not heated equally, which is not good for any type of boiler. Practical tests on many boilers have shown that with a blower and a small per cent. of good dry steam thoroughly mixed with the air under the ashpit, with a steady even pressure, keeps the grates in good order, gives more perfect combustion, leaving less ashes and clinkers than with the hand dampers closed to that point that, when the fire door is opened, there is only a slight inward draft, but no gases coming out. This will give a clear white flame and bring a plenum of slight prescure in the fire and combustion chambers. The shell or tubes will be evenly heated the whole length, giving more steam and yet keep the boiler in much better condition, while the saving in cost of fuel is from 5 per cent. to 50 per cent.

"In installing a new boiler plant the saving in the cost of erecting a tall chimney will more than pay for the cost of the forced draft system."

Personals.

—Alfred Augustus Raymond, inventor of the Raymond concrete pile and vice-president of the Raymond Concrete Pile Company, died recently at Regina, Canada.

—H. P. James, formerly electrical engineer of the Bryant Electric Co., is now sales manager for the new line of push-button specialties recently placed on the market by the Cutler-Hammer Mfg. Co., of Milwaukee.

—Hugh A. Brown has resigned from the Crocker-Wheeler Company, to whose Chicago office he has been attached for several years. He now takes up the work of sales manager for the Rockaway Coaster Company of Cincinnati.

Industrial Notes.

—The business of the Taper-Sleeve Pulley Works has passed into new hands and will hereafter be conducted by the Erie Clutch and Pulley Co., Erie, Pa.

—The Philadelphia office of the Raymond Concrete Pile Co. of New York and Chicago, has been moved from the Arcade Building to suite 1330, Land Title Building.

—A. S. Cameron Steam Pump Works, New York, have added a condenser department and are now prepared to build jet, surface and barometric condensers.

—The S. Obermayer Co., Cincinnati, are distributing a booklet which they have just gotten out on core compound and contains many hints for the core room.

—Trussed Concrete Steel Co., Detroit, have issued a folder treating of the precautions that must be taken in placing concrete in cold or freezing weather.

—In describing last month the tool post manufactured by the O. K. Tool Holder Co., a mistake was made in giving their address as Shelton, Pa. It is Shelton, Conn.

—The corporate name of The Dodge Coal Storage Co., Philadelphia, has been changed to The J. M. Dodge Co. James M. Dodge, chairman of the Link-Belt Co., is president.

—Keuffel & Esser Co. have opened a branch house in Montreal, Canada, at 252 Notre Dame street, West, where they will carry a complete line of their goods, and do blue printing, etc., for the trade.

—E. A. Ennis and E. J. Nelson, formerly with the Mergenthaler Linotype Co., as chief clerk and assistant chief clerk respectively, have opened offices at 173 York street, Jersey City, as factory systematizers under the firm name of Ennis & Nelson.

—The Raymond Concrete Pile Co., New York and Chicago, has been awarded the contract for placing concrete piles in the foundations of the machine shop, warehouse, and stables that are being built for the Ford & Kendig Co., at Twenty-fourth and Wood streets, Philadelphia.

—The Lesley & Trinkle Co., 603 Pennsylvania Building, Philadelphia, have reprinted in pamphlet form an article entitled, "Extensive Concrete Construction for Grain Storage," which appeared in *The Manufacturers' Record*, July 16, 1908.

—The Lidgerwood Manufacturing Co., New York, have recently been awarded the contract to furnish the cableways for erecting and constructing the Gatun locks of the Panama Canal. These cableways have a clear span of 800 feet and are self-propelling.

—The float entered by the New Process Raw Hide Co., in the Commercial float parade of the Ka-Noo-No Karnival, which is held annually in Syracuse, N. Y., in connection with the New York State Fair, won first prize in the machinery division.

—Ridgway Dynamo and Engine Co., announce the removal of their Philadelphia office from the Gerard Building to 1017 Witherspoon Building. This office is now under the management of Robert S. Beecher.

—The fifteenth annual meeting of the American Society of Heating and Ventilating Engineers will be held in the Engineering Societies' Building, 29 West Thirty-ninth street, New York, on January 19, 20 and 21, 1909.

—The Northern Water Softener Co., Madison, Wis., have issued a booklet in which they show, by the means of tables, that the installation of a water softener is an investment rather than an expense. Also contains views of some recent installations.

—C. E. Knoeppel, who has contributed a number of articles on systematic foundry operation and foundry cost to this Magazine, has associated himself with his father, J. C. Knoeppel, under the name of Knoeppel & Knoeppel as foundry specialists. They have opened offices at Erie, Pa.

—Turner Construction Co., New York, have just been awarded the general contract by the Alsen American Portland Cement Co. for the construction of a cement stock house 200 feet long by 38 feet wide by 34 feet high at their mills at Alsen, New York. These cement bins will be of reinforced concrete throughout.

—Orman B. Humphrey, consulting engineer, Bangor, Me., who for the past year has been engaged on the preliminary engineering in connection with the Ryegate Light & Power Co., hydro-electric development on Wells River, Vermont, has completed his work, and active construction has begun.

—The Nernst Lamp Company has received a contract from the Rosenbaum Company, proprietors of one of the largest department stores in Pittsburg, for an installation of 3-glower Westinghouse-Nernst lamps, replacing the 6-glower Nernst lamps which have been in use for the past four years.

—The Cleveland Crane & Car Co., Wickliffe, Ohio, having discontinued the manufacture of cars for many years past, will hereafter be known and operated as the Cleveland Crane & Engineering Co., and their production will be confined exclusively to the manufacture of cranes of every description.

—The Petroleum Iron Works Co., Sharon, Pa., are increasing their main shop by an addition of 80 x 150 feet at both ends of their present shop, which will make the final dimensions 150 x 480 feet. They are also installing a pipe dipping plant and other machinery that will enable them to handle any steel plate construction of any dimension or character.

—The G. M. McKelvey Co., Youngstown, have placed an order with the Nernst Lamp Co. for the new Westinghouse Nernst lamps for the entire lighting of their new four-story store building. The installation will consist of thirty-six three-glower lamps for the first floor, sixty-nine two-glower lamps for the second and third floors, and seventy-five 132-watt lamps for the basement and fourth floor.

—The Anglo-Newfoundland Development Co., Grand Falls, Newfoundland, through their engineer, George F. Hardy of New York, have awarded the contract for heating their immense buildings, now under construction at Grand Falls, to the American Blower Co., Detroit. The contract is now being executed speedily and all shipments from the factory are to be completed so as to arrive for transfer to steamer prior to December 1.

—The United Cigarette Machine Co., Lynchburg, Va., have recently placed an order with the Foos Gas Engine Co., Springfield, O., for one of their 100 h.p. multiple cylinder vertical engines and producer gas plants complete. The engine will be direct connected to a General Electric dynamo, to supply current for the operation of their magnificent new plant, which is nearing completion.

—Frederick B. Vail has severed his connection as general sales agent of the American Air Compressor Works, and announces the organization of the American Compres-

sor and Pump Co., for the manufacture of air and gas compressors, air receivers, vacuum pumps, etc. The sales offices will be located at 26 Cortlandt street, New York, and will be in charge of Mr. Vail. The works are at 718 East Pratt street, Baltimore, and are under the management of Alex. Slaysman, Jr.

—The annual meeting of the stockholders of The Rail Joint Company was held at the office of the company, Troy, N. Y., October 28. The following were chosen as directors: George G. Frelinghuysen, Frederick T. Fearey, E. Y. Weber, C. P. Wheeler, Mark T. Cox, Marcus L. Ward, F. C. Runyon, L. F. Braine, Percy Holbrook, Benjamin Y. Wolhaupter and George A. Weber. The directors of the company organized with these officers: Chairman of the board, George G. Frelinghuysen; president, Frederick T. Fearey; vice-presidents, L. F. Braine and Percy Holbrook; secretary, Benjamin Y. Wolhaupter; treasurer, F. C. Runyon.

—Steam users are beginning to realize and appreciate more and more the economic advantages of soft, clear water for boiler feed. Those not so fortunate as to have an available supply which does not cause scale or corrosion, or both, are installing water softening and purifying systems to remove the objectionable substances from the water before feeding into the boilers. This is the only rational method when the supply available is not what it should be. Wm. B. Scaife & Sons Co., Pittsburgh, Pa., manufacturers of the Scaife and We-Fu-Go water softening and purifying systems, report an extremely satisfactory year's business.

—*The General Electric Review*, published by the General Electric Co., Schenectady, for November, contains the following articles: Sprague-General Electric Automatic Control, by F. E. Case; Transmission of Electric Power, by E. B. Merriam; Variable Ratio Converters, Part I, by Chas. P. Steinmetz; Testing of Iron, Steel and Copper-Steel Cables for Transmission Line, by Ira M. Cushing; Gaso-Electric Motor Omnibuses on Fifth Avenue, New York City, by H. S. Baldwin; Motor Driven Envelope Factory, by A. F. Hemingway; Electric Locomotives for The Great Northern Railroad, The Low-Pressure Steam Turbine, by Charles B. Burleigh; Car Fender and Wheel Guard Tests at Schenectady, Automatic Starters for Polyphase Induction Motors, by C. D. Knight, and Circuit Breakers, by Charles Hubbard Hill.

NEW CATALOGUES AND TRADE PUBLICATIONS

NOTE.—The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. *See page 11.*

Arc Lamps.

WESTERN ELECTRIC CO., Chicago—Bulletin No. 5532 is devoted to an illustrated description of Victor flaming arc lamps. 8 by 10¾ in.; pp. 8.

Condensers.

WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J.—Bulletin No. 102 illustrates and describes surface condensers. Also contains notes and suggestions on the installation and operation of surface condensers. 8 by 10½ in.; pp. 24.

Crushers.

STURTEVANT MILL CO., Boston—Pamphlet illustrating and describing plate steel crushers. Balanced rolls and mining screens are also treated. 6½ by 8¾ in.; pp. 16.

PENNSYLVANIA CRUSHER CO., Philadelphia—Catalogue No. 11 illustrates and describes hammer, rotary and rock crushers. Magnetic separators and cleaners are also treated. 6 by 9 in.; pp. 24.

Drill Chucks.

T. R. ALMOND MFG. CO., Ashburnham, Mass.—Leaflet illustrating and describing enclosed pinion drill chucks, together with price list. 3½ by 6 in.; pp. 6.

Drills.

PRATT & WHITNEY CO., Hartford, Conn.—Well-printed catalogue illustrating and describing multiple drilling machines adapted for various classes of work. Also gives specifications. 9 by 12 in.; pp. 28.

Electrical Equipment.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Bulletins Nos. 4621 and 4627 illustrate and describe luminous arc lamps and curve-drawing instruments for alternating and direct current circuits.

WESTERN ELECTRIC CO., Chicago—Bulletin No. 5910-S describes electrical equipment for mines and is illustrated with views showing some recent installations. 8 by 10½ in.; pp. 24.

CROCKER-WHEELER CO., Ampere, N. J.—Bulletins Nos. 106, 107, 108 and 109 illustrate and describe respectively direct current switchboard panels; direct current lighting and power generators; engine type alternating current generators; and generating sets with type "D" engines.

Feed Water Purifier.

F. E. Keyes & Son, 22 Broad St., New York —Folder briefly describing feed water purifiers. Feed water heaters, boiler tube cleaners and flue blowers are also treated. Illustrated. 3½ by 6 in.; pp. 4.

Friction Clutches.

Carlyle Johnson Machine Co., Hartford, Conn.—Catalogue D contains an illustrated description, together with sizes, prices, etc., of friction clutches. Also contains much valuable information in regard to driving machinery direct from line shafting, through friction clutches, thus eliminating countershafting, cross belting, etc. 4½ by 7 in.; pp. 36.

Gas Producers.

Gas Machinery Co., Citizens Bldg., Cleveland —Bulletin illustrating and describing Wile gas producers for non-bituminous fuels. Made in units from 35 to 300 horsepower. 6 by 9 in.; pp. 16.

Heating and Ventilating Apparatus.

Buffalo Forge Co., Buffalo—Catalogue No. 197 illustrates and describes the Buffalo fan system of heating and ventilating. Also contains chapters on the heating and ventilating of public buildings and industrial plants; heating and ventilating apparatus and data on heating and ventilating. 6 by 9 in.; pp. 144.

Iron Pipe.

Reading Iron Co., Reading, Pa.—Booklet containing a price list and brief description of wrought iron pipe for steam, gas and water. Casing, line and drive pipe, oil well tubing and boiler tubes are also given a place. 3½ by 6 in.; pp. 36.

Melting Furnaces.

W. S. Rockwell Co., 50 Church St., New York—Bulletin illustrating and describing crucible melting furnaces for copper, brass, bronze, aluminum, silver, gold, nickel, iron, steel, etc. Oil or gas fuel can be used. 6 by 9 in.; pp. 8.

Metal Lath.

Northwestern Expanded Metal Co., 930 Old Colony Bldg., Chicago—Booklet illustrating and describing metal plastering lath. Also contains much useful information for contractors, plasterers, etc. 3¼ by 6 in.; pp. 12.

General Fireproofing Co., Youngstown, Ohio —Catalogue devoted to an illustrated description of metal lath, studding, wall ties, and concrete reinforcement. Steel filing devices, desks, tables and lockers are also treated. 3½ by 8 in.; pp. 24.

Metal Saw Table.

Hub Machine & Tool Co., Philadelphia—Several folders containing an illustrated description of metal saw tables, together with sizes, weights, prices, etc. Also gives a partial list of users.

Milling Machines.

Cincinnati Milling Machine Co., Cincinnati —Well-printed catalogue illustrating and describing high power horizontal and vertical milling machines. 6 by 9 in.; pp. 52.

Reinforced Concrete Construction.

Turner Construction Co., 11 Broadway, New York—Bulletin No. 4 illustrates and briefly describes the reinforced concrete warehouse, factory and office recently erected for the Great Atlantic & Pacific Tea Co., at Jersey City, N. J. 9 by 11 in.; pp. 8.

Riveted Pipe.

American Spiral Pipe Works, 14th St. and 48th Ave., Chicago—Catalogue No. 5 contains a brief description of spiral riveted pipe and forged steel flanges and is illustrated with views showing many large installations of long water supply lines and exhaust steam piping equipment. Also contains tables giving dimensions, prices, etc. 8 by 10 in.; pp. 78.

Riveters.

Hanna Engineering Works, 820 Elston Ave., Chicago—Catalogue No. 3 illustrates and describes many types of pneumatic riveters. Also contains tables giving sizes. 6 by 9 in.; pp. 64.

Riveting Machine.

Harvey Hubbell, Inc., Bridgeport, Conn.—Booklet illustrating and describing riveting and screw slotting machines. 3½ by 6¼ in.; pp. 12. Also a booklet treating of tapping machines. Illustrated. 3½ by 6¼ in.; pp. 12.

Separators.

Harrison Safety Boiler Works, 3138 N. 17th St., Philadelphia—Separator Talks is the title of a booklet devoted to the explanation of the first principles of separating water or oil from steam or gases. A study is made of the various devices for taking water out of live steam, purifying exhaust steam from cylinder oil (non-condensing and condensing systems), removing oil, grit and moisture from ammonia currents and compressed air, etc. 3½ by 6 in.; pp. 20.

Smokeless Furnaces.

Harris Smokeless Furnace Co., Nashville, Tenn.—Catalogue illustrating and describing smokeless furnaces designed exclusively for all types of externally fired boilers carrying high pressure for power purposes. 10 by 7½ in.; pp. 48.

Special Machinery.

Reuter-Jones Mfg. Co., 1607 South Third St., St. Louis—Catalogue G-6 illustrates and describes, together with tables giving dimensions, prices, etc., factory, mill, elevator, transmission and special machinery. The catalogue is cloth bound and fully indexed. 6 by 9 in.; pp. 516.

Steam Shovels.

John Souther & Co., 185 Summer St., Boston —"The Cost of Steam Shovel Work in Railway Betterment" is the title of a booklet showing the cost of doing work by shovels in making cut-offs, double tracking or bettering grades. 3½ by 6½ in.; pp. 8.

Telephone Cables.

Western Electric Co., 483 West St., New York—Booklet No. 1150 treats of lead covered telephone cables and the telephone cable field quite comprehensively. Illustrated. 3½ by 6 in.; pp. 12.

Swing Saw.

Carse Bros. Co., 165 Broadway, New York—Bulletin No. 101 briefly describes electrically driven swing saws. Also contains tables giving dimensions and weights. Illustrated. 8¾ by 11¼ in.; pp. 4.